Apple Inc. vs High Tech Computer Corp., a/k/a/ HTC Corp. Doc. 92 Att. 4

EXHIBIT C

Dockets.Justia.com

US007657849B2

(12) **United States Patent**
Chaudhri et al.

(10) **Patent No.: US 7,657,849 B2**
(45) **Date of Patent: Feb. 2, 2010**

(54) **UNLOCKING A DEVICE BY PERFORMING GESTURES ON AN UNLOCK IMAGE**

(75) Inventors: **Imran Chaudhri**, San Francisco, CA (US); **Bas Ording**, San Francisco, CA (US); **Freddy Allen Anzures**, San Francisco, CA (US); **Marcel Van Os**, San Francisco, CA (US); **Stephen O. Lemay**, San Francisco, CA (US); **Scott Forstall**, Mountain View, CA (US); **Greg Christie**, San Jose, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 394 days.

(21) Appl. No.: **11/322,549**

(22) Filed: **Dec. 23, 2005**

(65) **Prior Publication Data**

US 2007/0150842 A1 Jun. 28, 2007

(51) **Int. Cl.**
G06F 3/033 (2006.01)

(52) **U.S. Cl.** **715/863**; 345/173; 345/179

(58) **Field of Classification Search** 713/154, 713/156, 182; 715/853, 863; 345/173, 179, 345/156

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,465,084	A	11/1995	Cottrell	340/825.31
5,559,961	A	9/1996	Blonder	395/188.01
5,677,710	A	10/1997	Thompson-Rohrlich	345/173
5,821,933	A *	10/1998	Keller et al.	715/741
5,907,327	A	5/1999	Ogura et al.	345/339
6,151,208	A	11/2000	Bartlett	361/683
6,160,555	A	12/2000	Kang et al.	345/358
6,192,478	B1	2/2001	Elledge	713/202
6,249,606	B1	6/2001	Kiraly et al.	702/195
6,323,846	B1	11/2001	Westerman et al.	345/173
6,347,290	B1	2/2002	Bartlett	702/150

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1 284 450 A2 2/2003

(Continued)

OTHER PUBLICATIONS

GridLock 1.32, Oct. 8, 2003, pp. 1-2, http://gridlock.en.softonic.com/palm.*

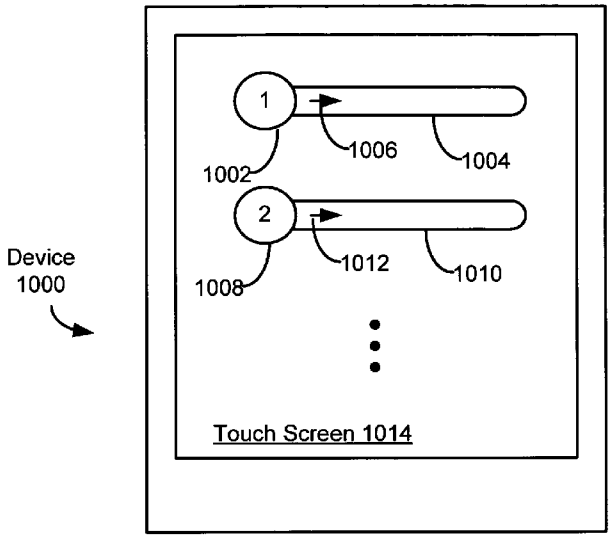
(Continued)

Primary Examiner—Dennis-Doon Chow
Assistant Examiner—Andres E Gutierrez
(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

A device with a touch-sensitive display may be unlocked via gestures performed on the touch-sensitive display. The device is unlocked if contact with the display corresponds to a predefined gesture for unlocking the device. The device displays one or more unlock images with respect to which the predefined gesture is to be performed in order to unlock the device. The performance of the predefined gesture with respect to the unlock image may include moving the unlock image to a predefined location and/or moving the unlock image along a predefined path. The device may also display visual cues of the predefined gesture on the touch screen to remind a user of the gesture.

23 Claims, 15 Drawing Sheets



U.S. PATENT DOCUMENTS

6,421,453	B1	7/2002	Kanevsky et al.	382/115
6,570,557	B1	5/2003	Westerman et al.	345/173
6,573,883	B1	6/2003	Bartlett	345/156
6,633,310	B1	10/2003	Andrew et al.	345/728
6,677,932	B1	1/2004	Westerman	345/173
6,720,860	B1	4/2004	Narayanaswami	340/5.54
6,735,695	B1	5/2004	Gopalakrishnan et al.	713/186
7,124,433	B2	10/2006	Little	726/2
7,151,843	B2	12/2006	Rui et al.	382/103
7,174,462	B2	2/2007	Pering et al.	713/182
7,263,670	B2	8/2007	Rekimoto	715/837
2001/0011308	A1	8/2001	Clark et al.	710/20
2001/0012022	A1	8/2001	Smith	345/768
2002/0015024	A1	2/2002	Westerman et al.	345/173
2002/0196274	A1	12/2002	Comfort et al.	345/741
2003/0142138	A1	7/2003	Brown et al.	345/797
2004/0030934	A1	2/2004	Mizoguchi et al.	713/202
2004/0034801	A1 *	2/2004	Jaeger	713/202
2004/0085351	A1	5/2004	Tokkonen	345/741
2004/0088568	A1	5/2004	Tokkonen	713/200
2004/0230843	A1	11/2004	Jansen	713/202
2004/0250138	A1	12/2004	Schneider	713/202
2004/0260955	A1	12/2004	Mantyla	713/202
2004/0268267	A1	12/2004	Moravcsik	715/821
2005/0050477	A1	3/2005	Robertson et al.	715/853
2005/0060554	A1	3/2005	O'Donoghue	713/183
2005/0079896	A1	4/2005	Kokko et al.	455/566
2005/0212760	A1 *	9/2005	Marvit et al.	345/156
2005/0216862	A1	9/2005	Shinohara et al.	715/825
2005/0248542	A1	11/2005	Sawanobori	345/173
2005/0253817	A1 *	11/2005	Rytivaara et al.	345/173
2005/0264833	A1	12/2005	Hiraoka et al.	358/1.9
2006/0174339	A1	8/2006	Tao	726/18
2006/0267955	A1	11/2006	Hino	345/173
2008/0034292	A1	2/2008	Brunner et al.	715/700
2008/0072172	A1	3/2008	Shinohara et al.	715/772

FOREIGN PATENT DOCUMENTS

GB	2 313 460	A	11/1997
JP	60 171560		9/1985
JP	2 249062		10/1990
JP	6 214954		8/1994
WO	WO 02/33882	A1	4/2002
WO	WO 04/001560	A1	12/2003
WO	WO 2004/021108	A2	3/2004

OTHER PUBLICATIONS

A Passive-Style Buttonless Mobile Terminal; Youichi Horry, Issyu Nakajima, Takeshi Hoshino, and Yukinobu Maruyama; IEEE Transactions on Consumer Electronics; vol. 49; No. 3; Aug. 2003; pp. 530-535.*

PCT International Search Report for International Application No. PCT/US2006/061370, mailed May 25, 2007.

IBM Corp., "Access/Control Icons (Icon Keys)," IBM Technical Disclosure Bulletin, vol. 38, No. 4, Apr. 1995, pp. 407-409.

"Touch Password Protection," JGUI Professional, http://www.jgui.net/touch/index.html, Dec. 8, 2003.

Office Action dated Oct. 31, 2007 for related U.S. Appl. No. 11/322,550, filed Dec. 23, 2005, pp. 1-26.

Office Action dated Apr. 21, 2008 for related U.S. Appl. No. 11/322,550, filed Dec. 23, 2005, pp. 1-22.

International Search Report for International Application No. PCT/US2006/061380, mailed Apr. 23, 2007.

Notice of Allowance dated Sep. 19, 2008, for related U.S. Appl. No. 11/322,550.

Bardram, J., "The Trouble with Login: on usability and computer security in Ubiquitous Computing," Centre for Pervasive Healthcare, Department of Computer Science, University of Aahus, Published online: Jul. 23, 2005.

Fitzpatrick, G. et al., "Method for Access Control via Gestural Verification," IBM Technical Disclosure Bulletin, vol. 36, No. 09B, Sep. 1993, 2 pages.

IBM, "Touch Pad Authentication," Sep. 21, 2004, 2 pages.

Jansen, W., "Authenticating Users on Handheld Devices," The National Institute of Standards and Technology, Gaithersburg, Maryland, 2003, 13 pages.

Jermyn, I. et al., "The Design and Analysis of Graphical Passwords," Submission to the 8th Usenix Security Symposium, Aug. 1999, 15 pages.

Monrose, N., "Towards Stronger User Authentication," Ph.d dissertation, 1999, New York University, vol. 60/05-B of Dissertation Abstract International, Order No. AAD99-30229, 115 pages.

Najjar, L., "Graphical Passwords," International Technology Disclosures vol. 10, No. 1, Jan. 25, 1992, 1 page.

Renaud, K. et al., "My Password is Here! An Investigation into Visuo-Spatial Authentication Mechanisms," 2004, 25 pages, www.sciencedirect.com.

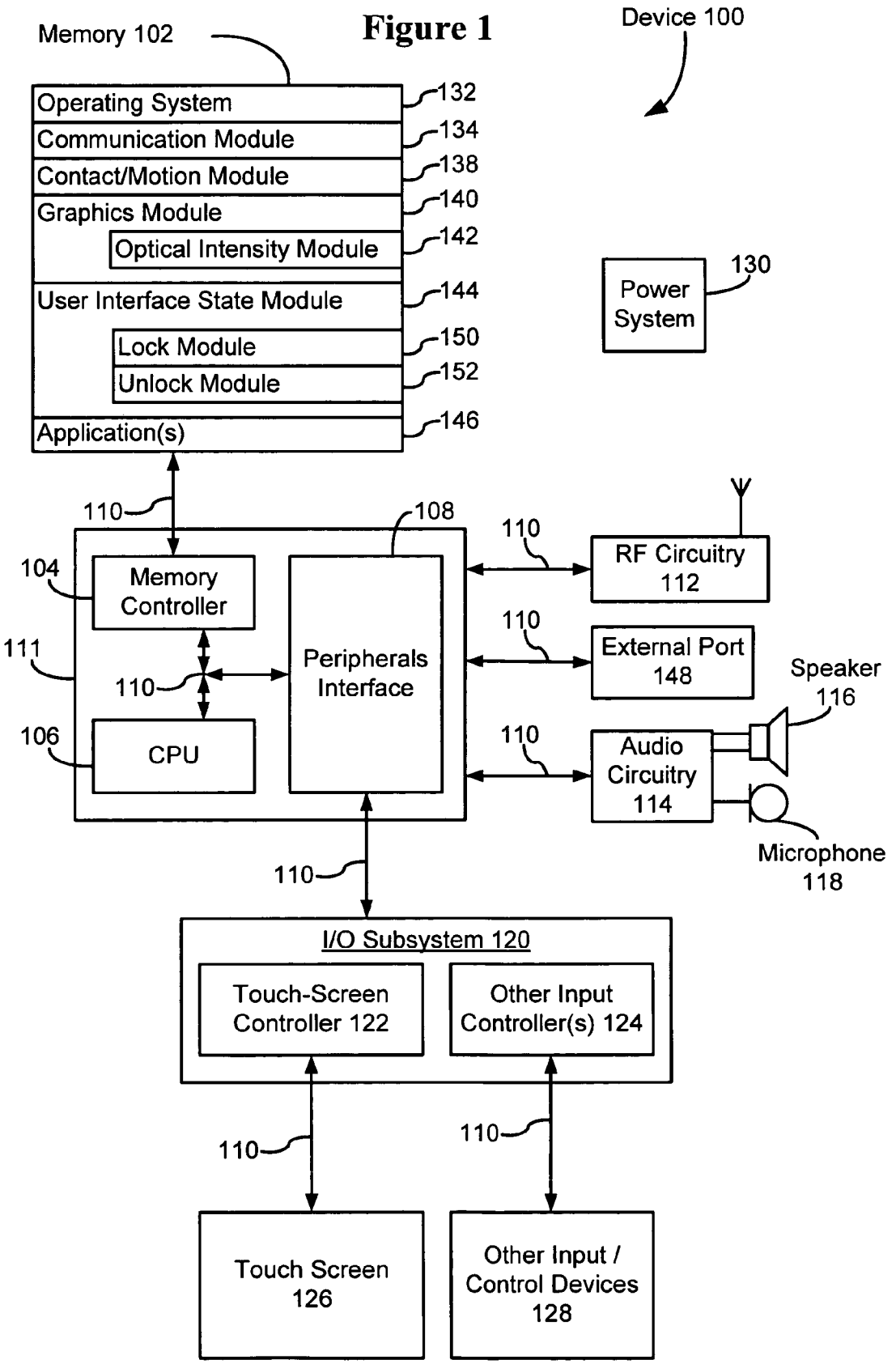
Wiedenbeck, S., et al. "PassPoints: Design and Longitudinal Evaluation of a Graphical Password System," International Journal of Human-Computer Studies, vol. 63, Issues 1-2, Jul. 2005, pp. 102-127.

Office Action dated Feb. 4, 2009, received in the German patent application which corresponds to U.S. Appl. No. 11/322,549.

Office Action dated Mar. 25, 2009, received in the European patent application which corresponds to U.S. Appl. No. 11/322,549.

* cited by examiner

Figure 1


Device 100
Memory 102
Operating System
132
Communication Module
134
Contact/Motion Module
138
Graphics Module
140
Optical Intensity Module
142
User Interface State Module
144
Lock Module
150
Unlock Module
152
Application(s)
146
Power System
130
110
108
104
Memory Controller
111
Peripherals Interface
CPU
106
RF Circuitry 112
External Port 148
Speaker 116
Audio Circuitry 114
Microphone 118
I/O Subsystem 120
Touch-Screen Controller 122
Other Input Controller(s) 124
Touch Screen 126
Other Input / Control Devices 128

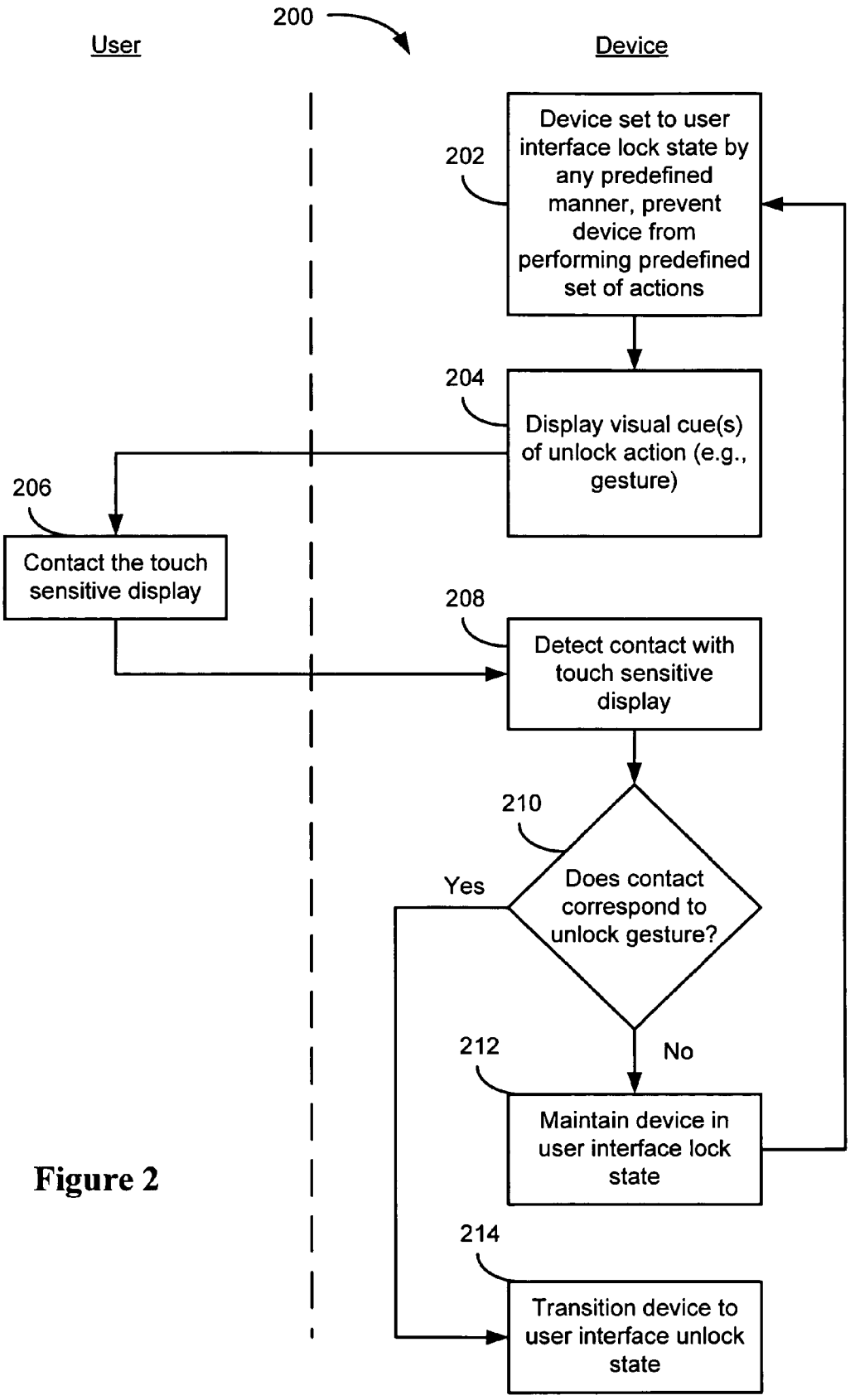

200
User
Device
202
Device set to user interface lock state by any predefined manner, prevent device from performing predefined set of actions
204
Display visual cue(s) of unlock action (e.g., gesture)
206
Contact the touch sensitive display
208
Detect contact with touch sensitive display
210
Does contact correspond to unlock gesture?
Yes
No
212
Maintain device in user interface lock state
214
Transition device to user interface unlock state

Figure 2

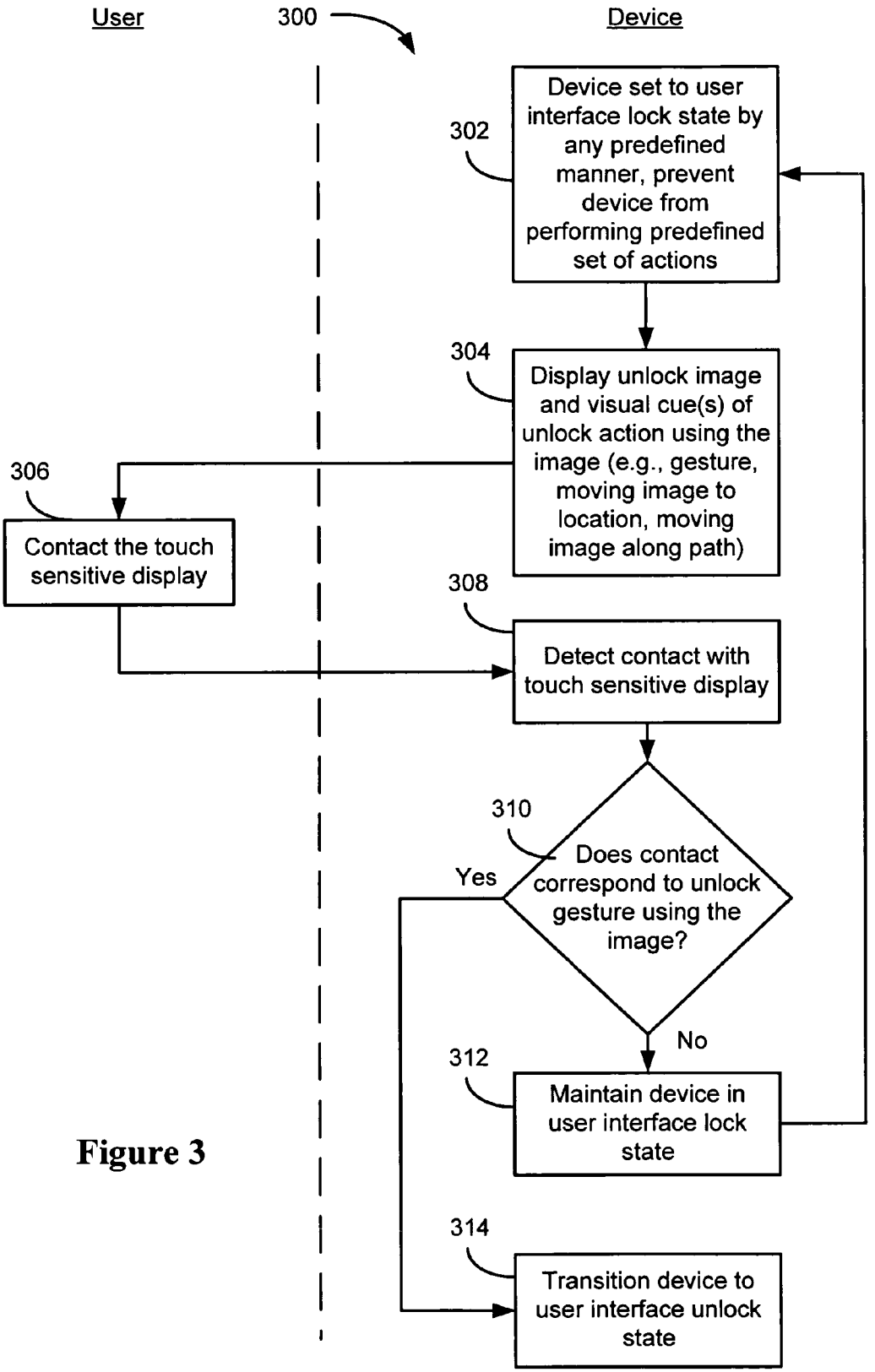

User
300
Device
Device set to user interface lock state by any predefined manner, prevent device from performing predefined set of actions
302
Display unlock image and visual cue(s) of unlock action using the image (e.g., gesture, moving image to location, moving image along path)
304
306
Contact the touch sensitive display
308
Detect contact with touch sensitive display
310
Does contact correspond to unlock gesture using the image?
Yes
No
312
Maintain device in user interface lock state
314
Transition device to user interface unlock state

Figure 3

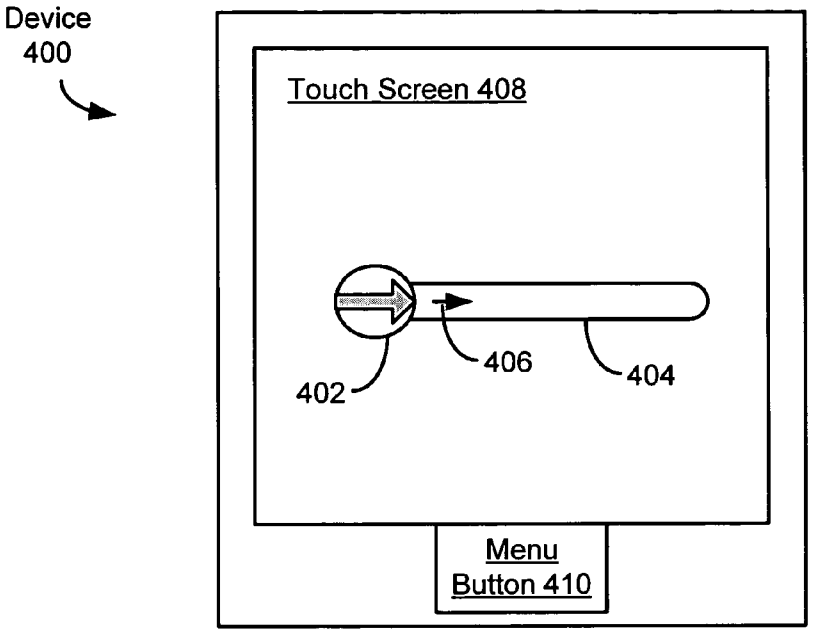


Figure 4A

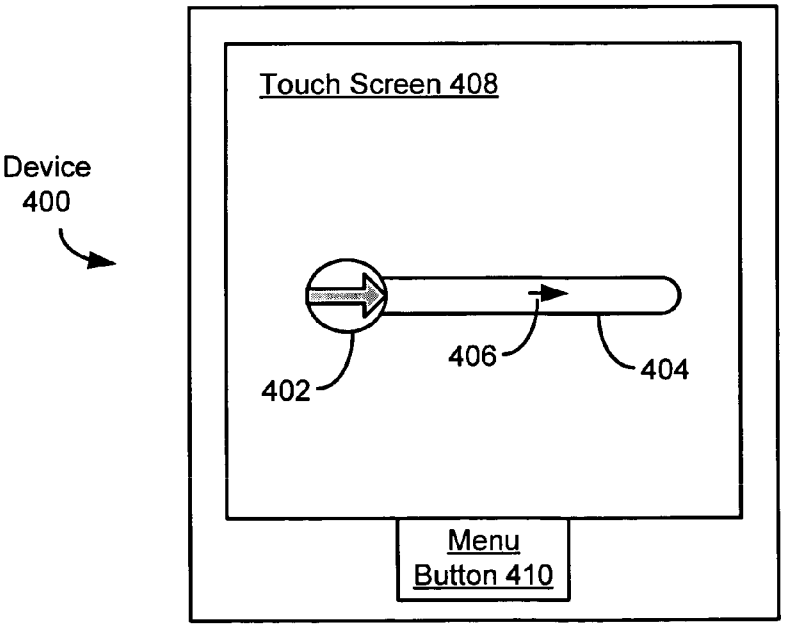


Figure 4B

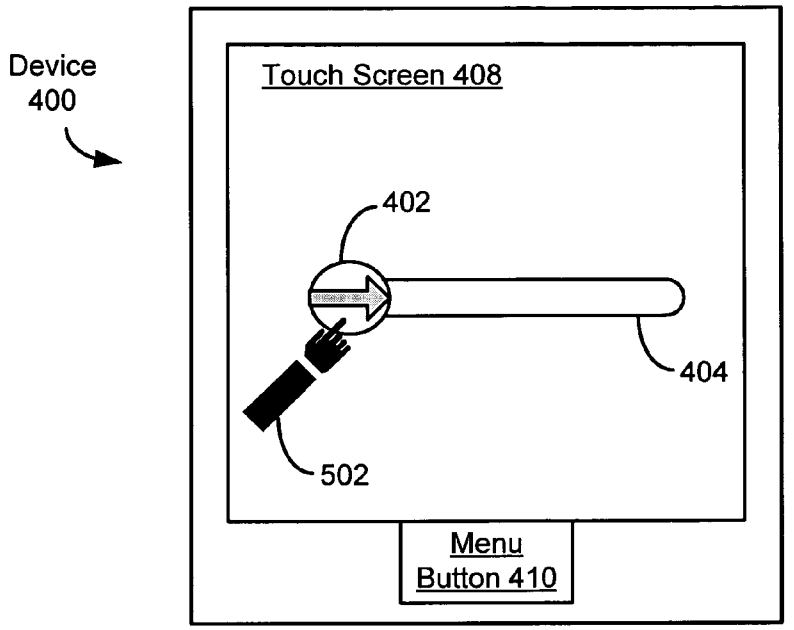


Figure 5A

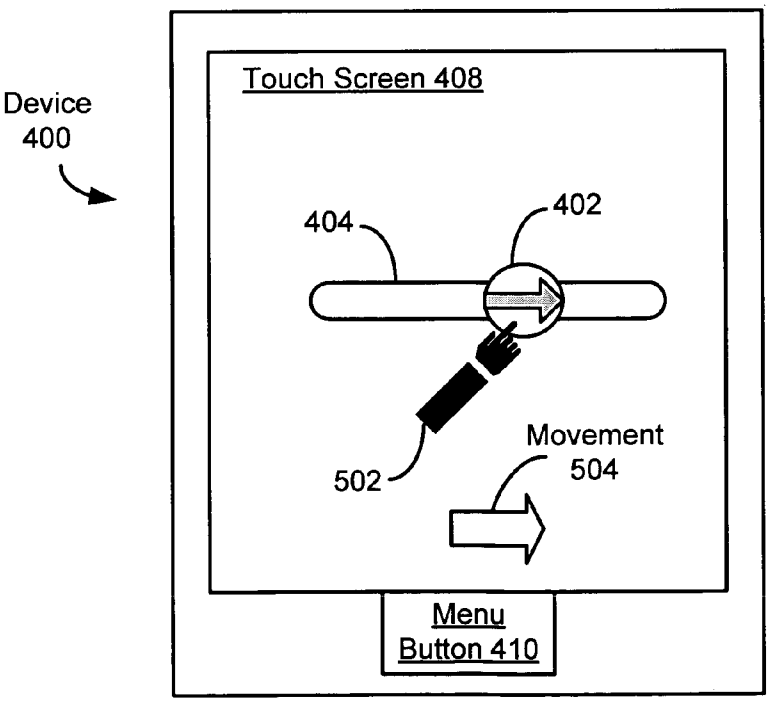


Figure 5B

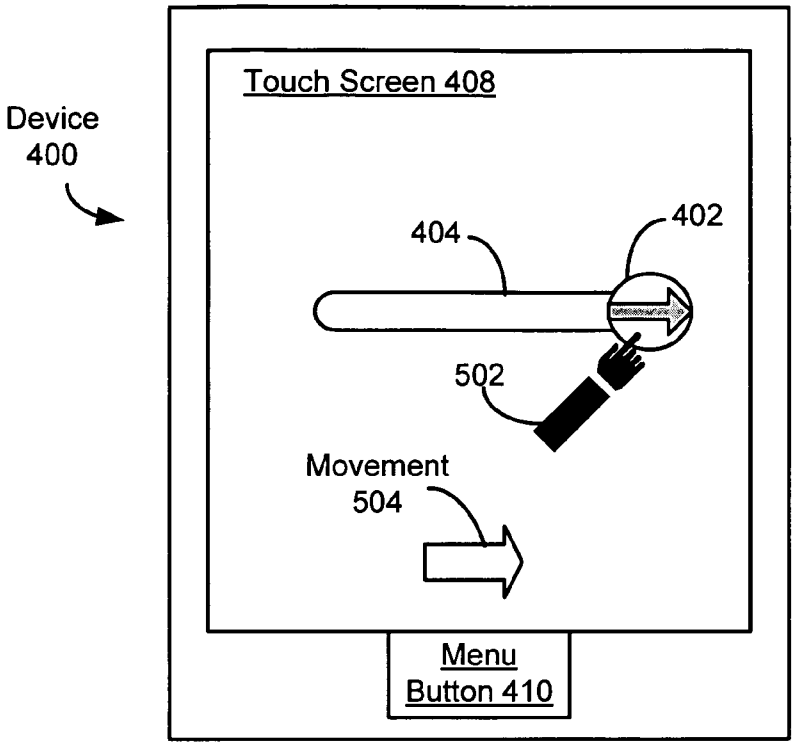


Figure 5C

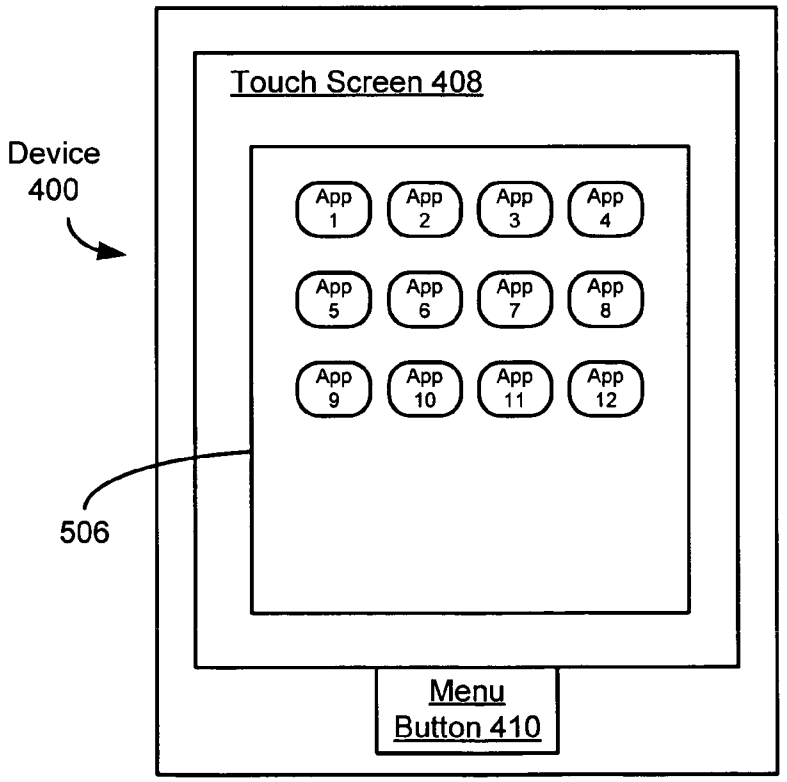


Figure 5D

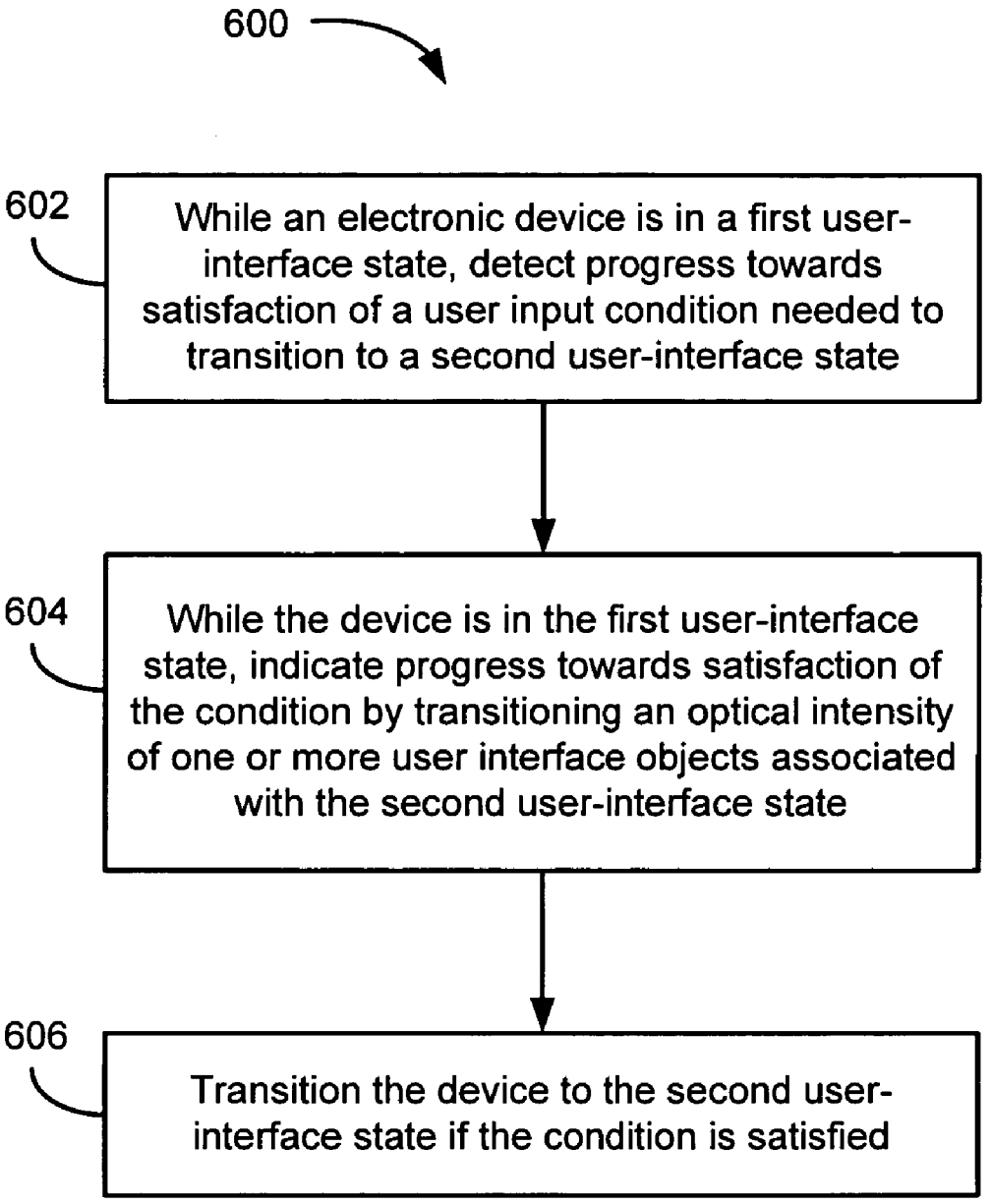

600
602
While an electronic device is in a first user-interface state, detect progress towards satisfaction of a user input condition needed to transition to a second user-interface state
604
While the device is in the first user-interface state, indicate progress towards satisfaction of the condition by transitioning an optical intensity of one or more user interface objects associated with the second user-interface state
606
Transition the device to the second user-interface state if the condition is satisfied

Figure 6

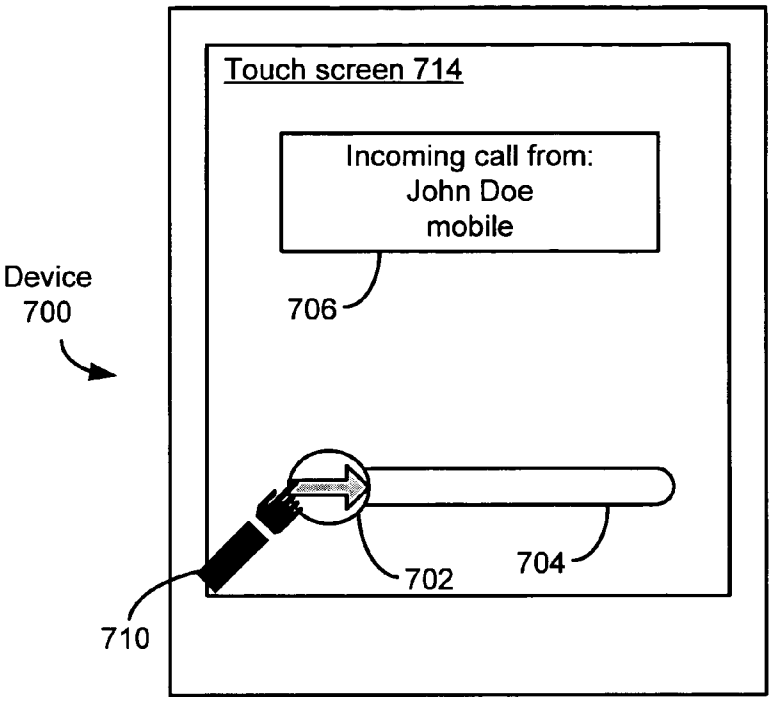


Figure 7A

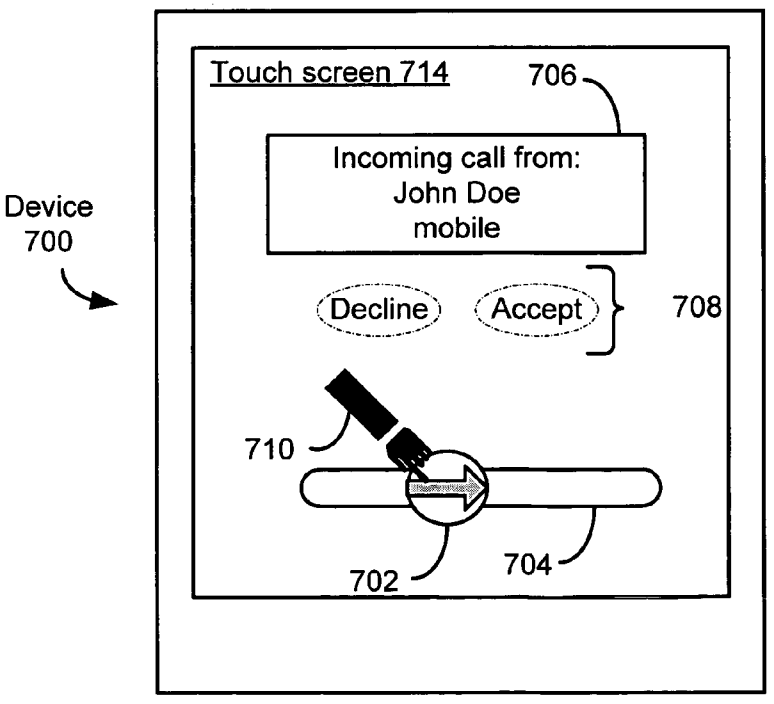


Figure 7B

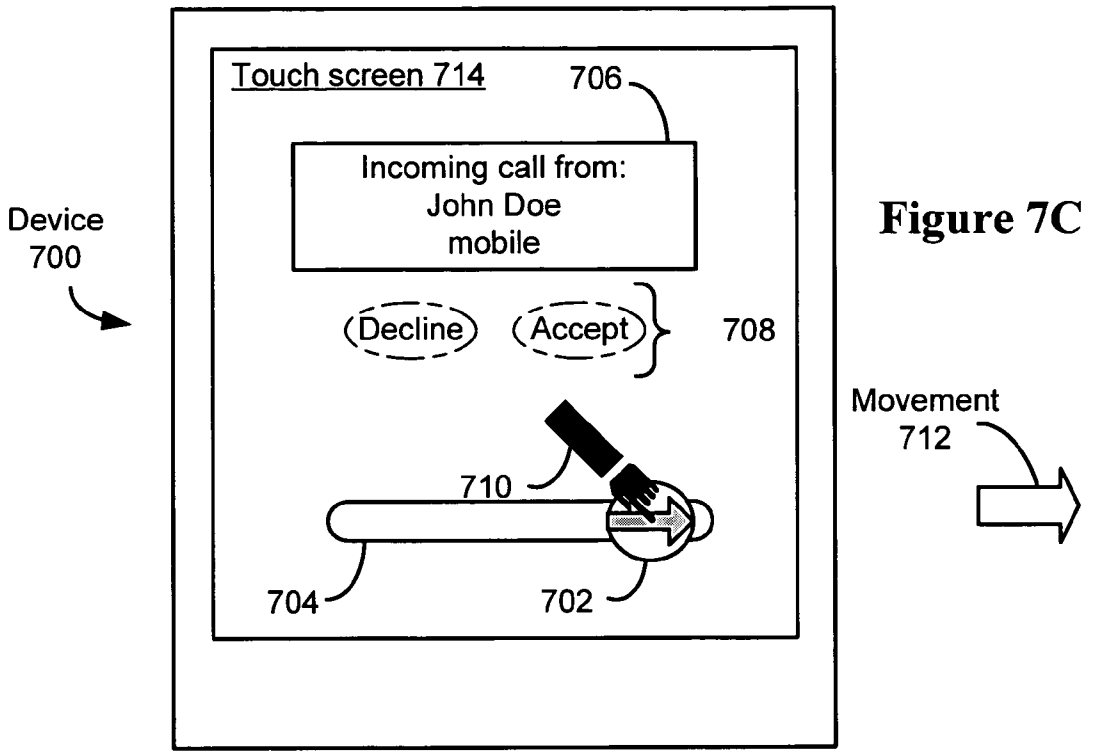


Figure 7C

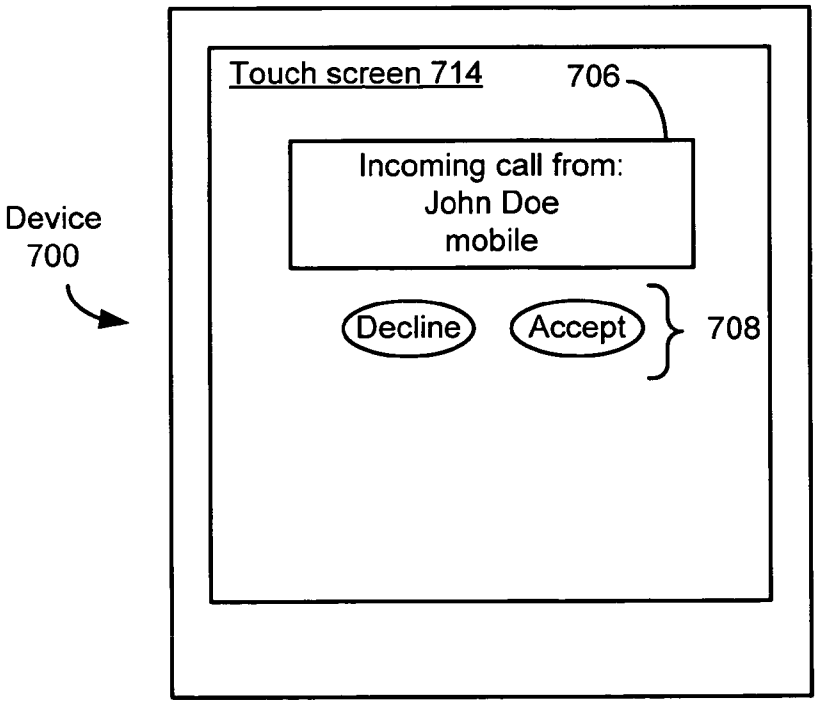


Figure 7D

Figure 8A

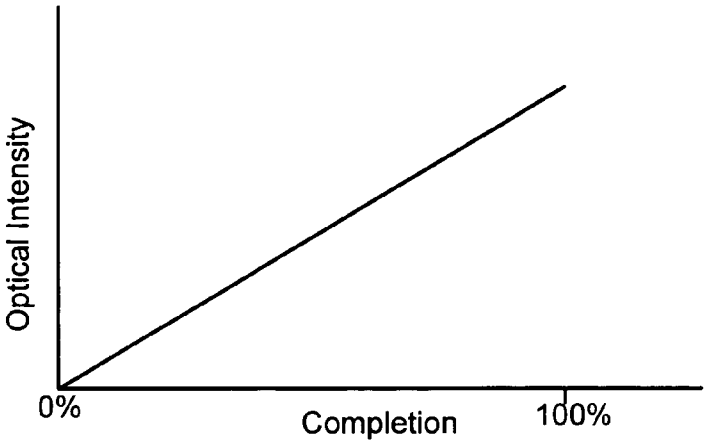


Figure 8B

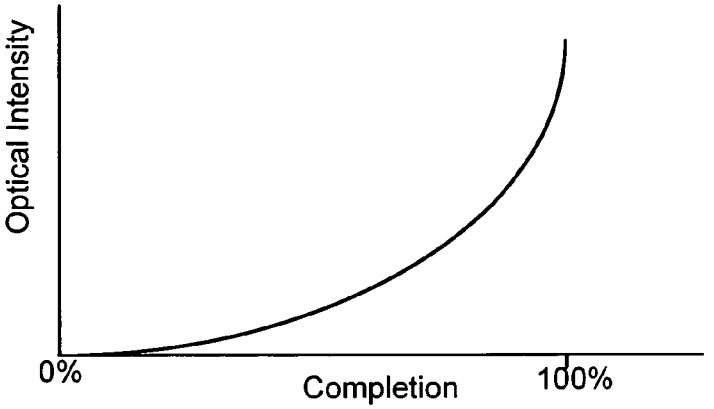
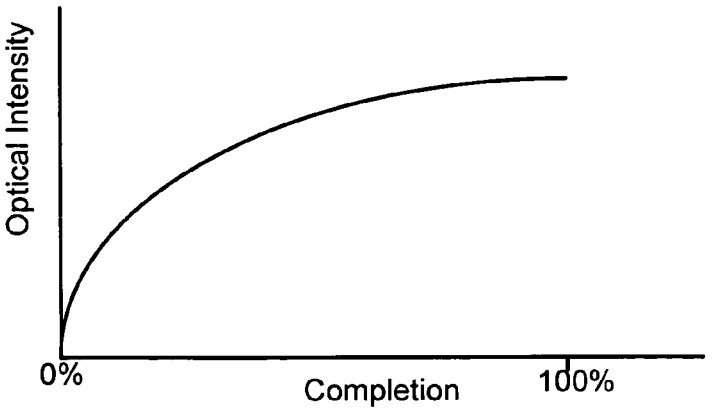


Figure 8C



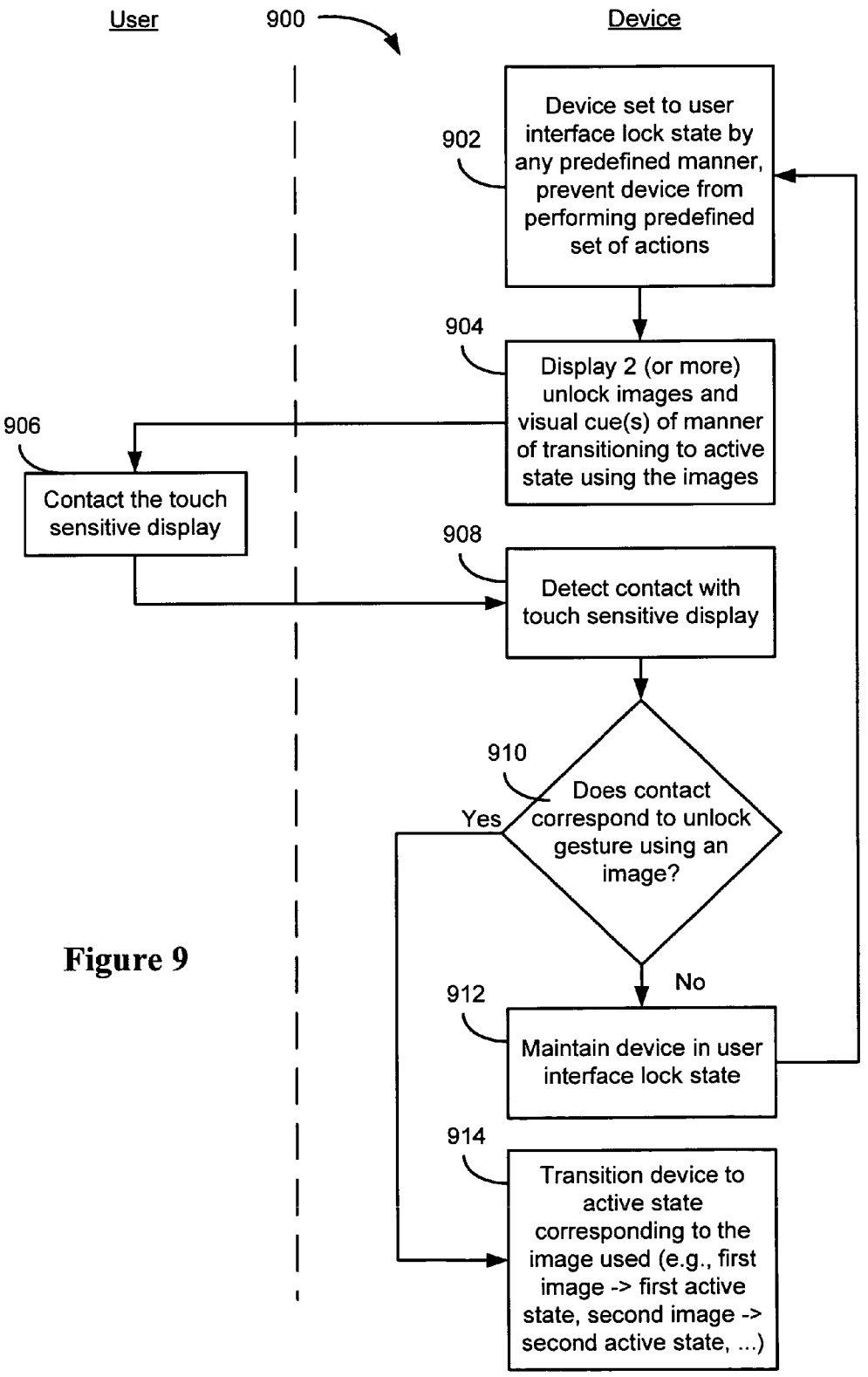

User
900
Device
902
Device set to user interface lock state by any predefined manner, prevent device from performing predefined set of actions
904
Display 2 (or more) unlock images and visual cue(s) of manner of transitioning to active state using the images
906
Contact the touch sensitive display
908
Detect contact with touch sensitive display
910
Does contact correspond to unlock gesture using an image?
Yes
No
912
Maintain device in user interface lock state
914
Transition device to active state corresponding to the image used (e.g., first image -> first active state, second image -> second active state, ...)

Figure 9

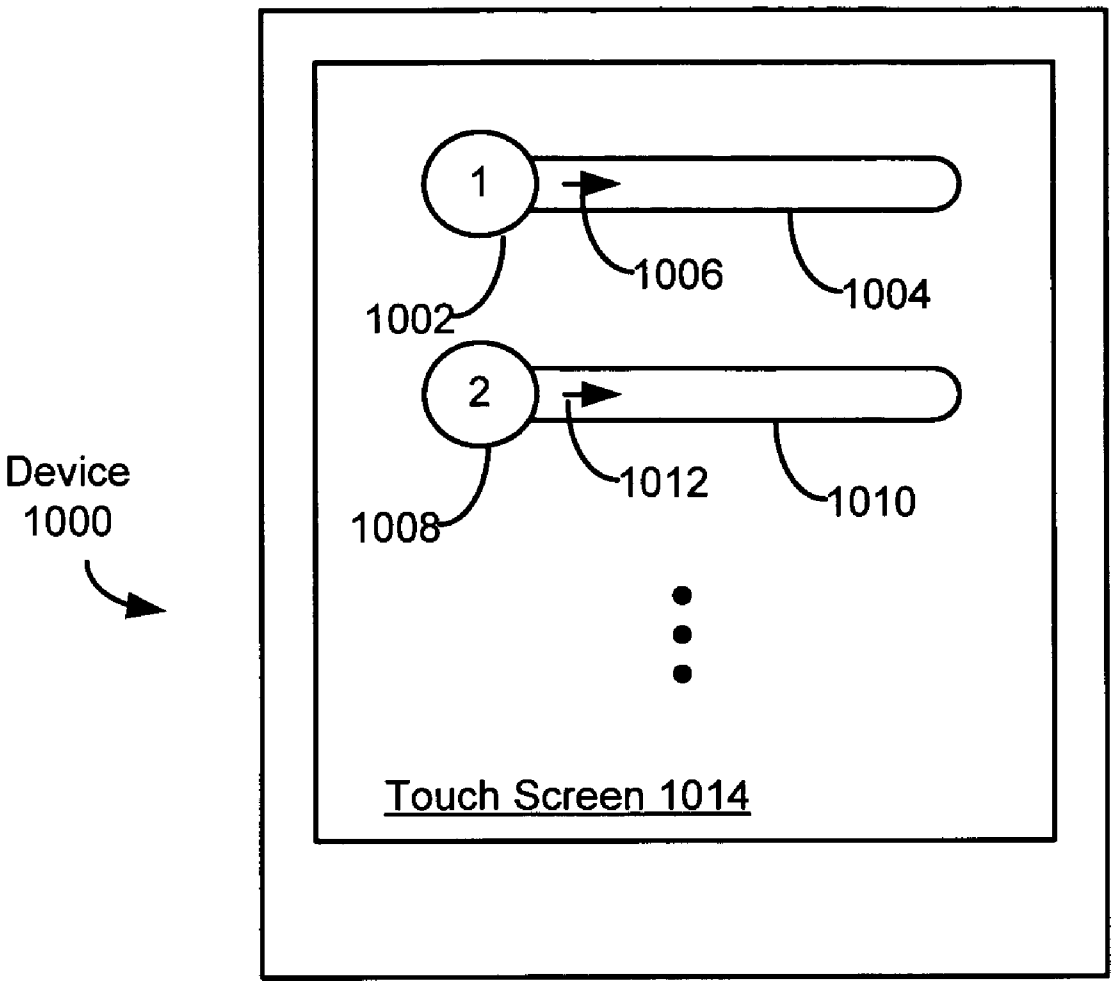

Device
1000
1
1002
1006
1004
2
1008
1012
1010
Touch Screen 1014

Figure 10

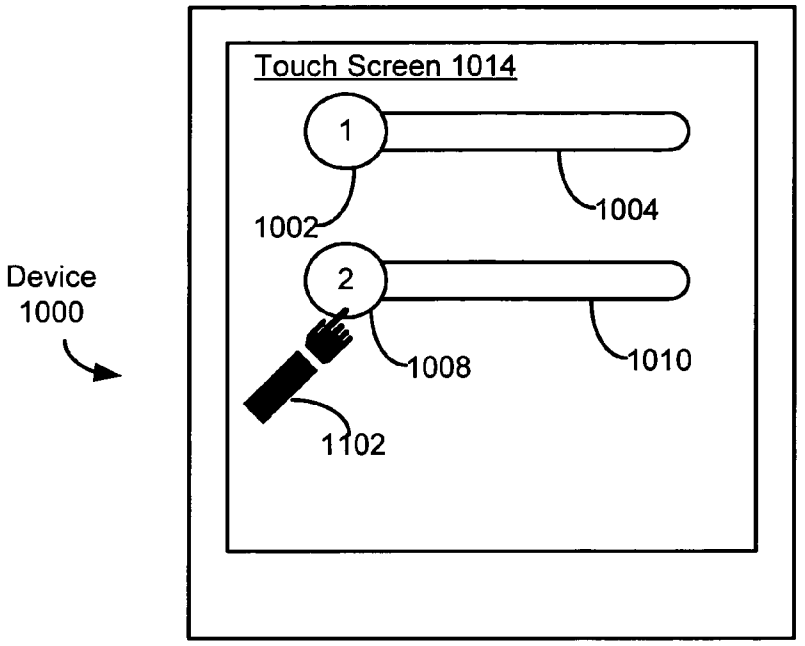


Figure 11A

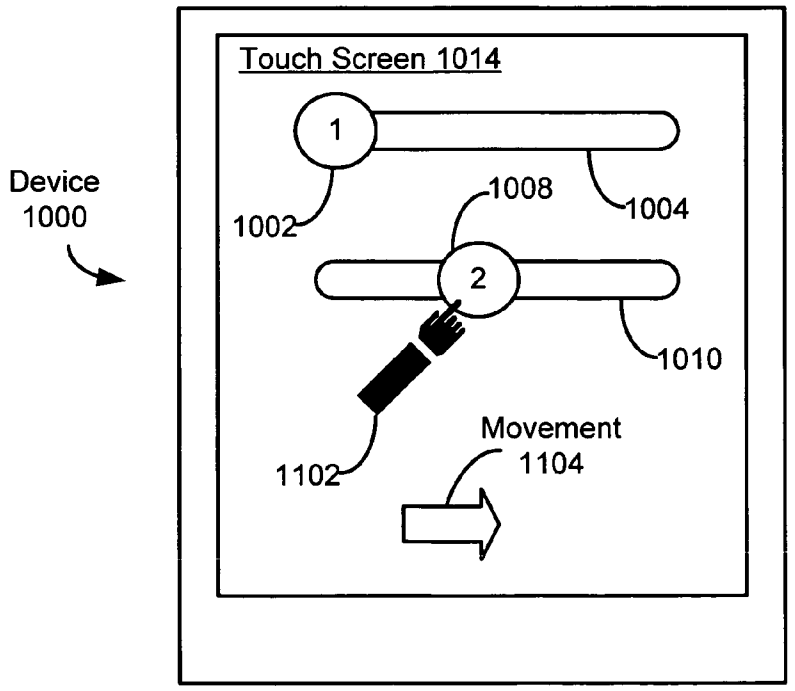


Figure 11B

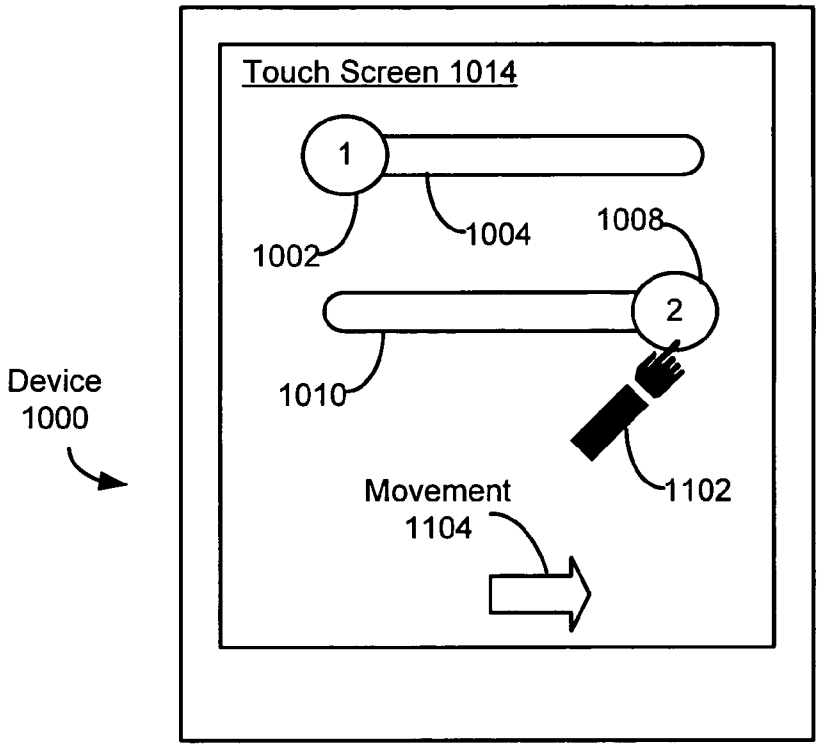


Figure 11C

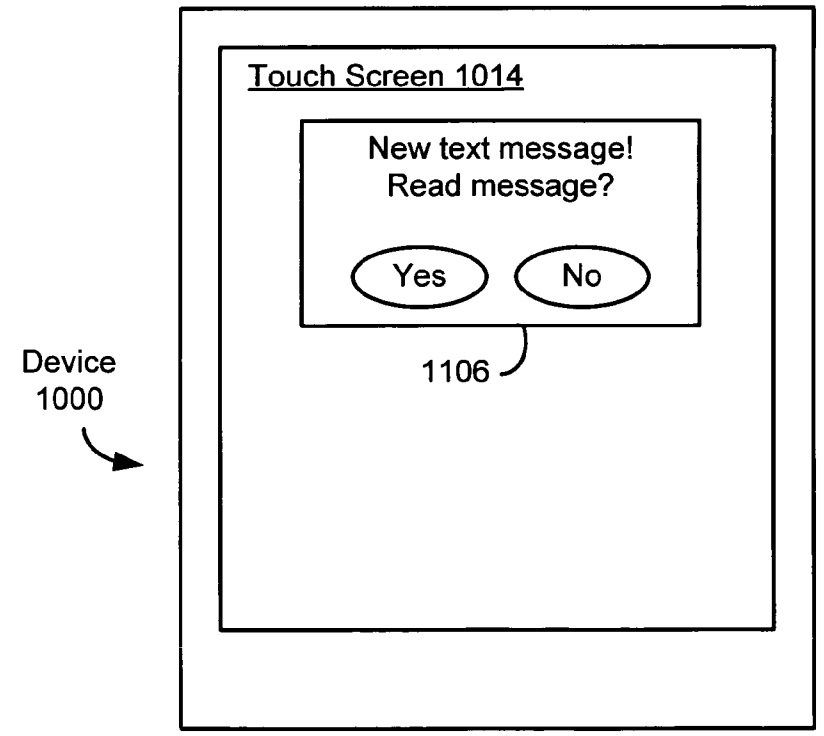


Figure 11D

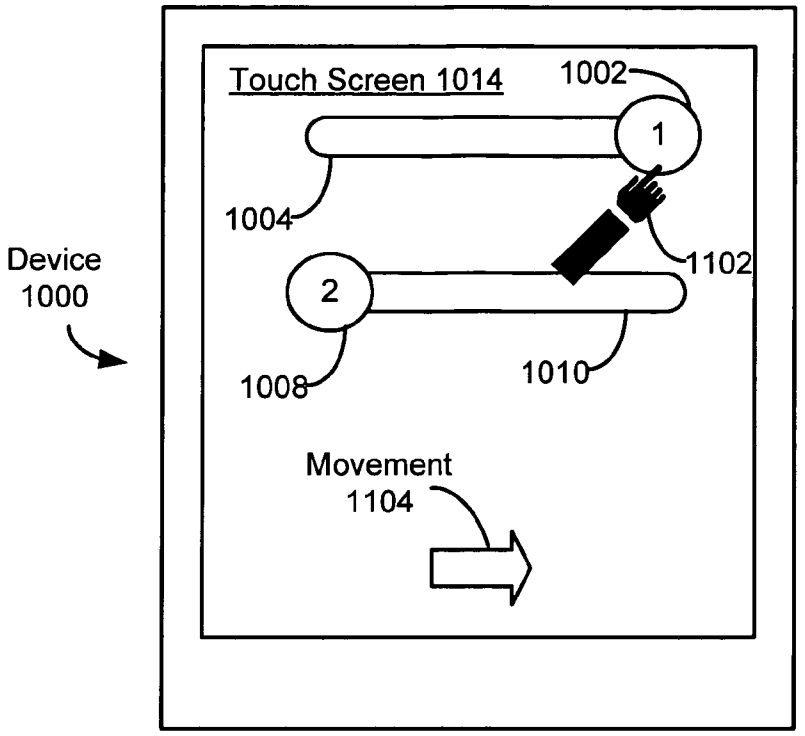


Figure 11E

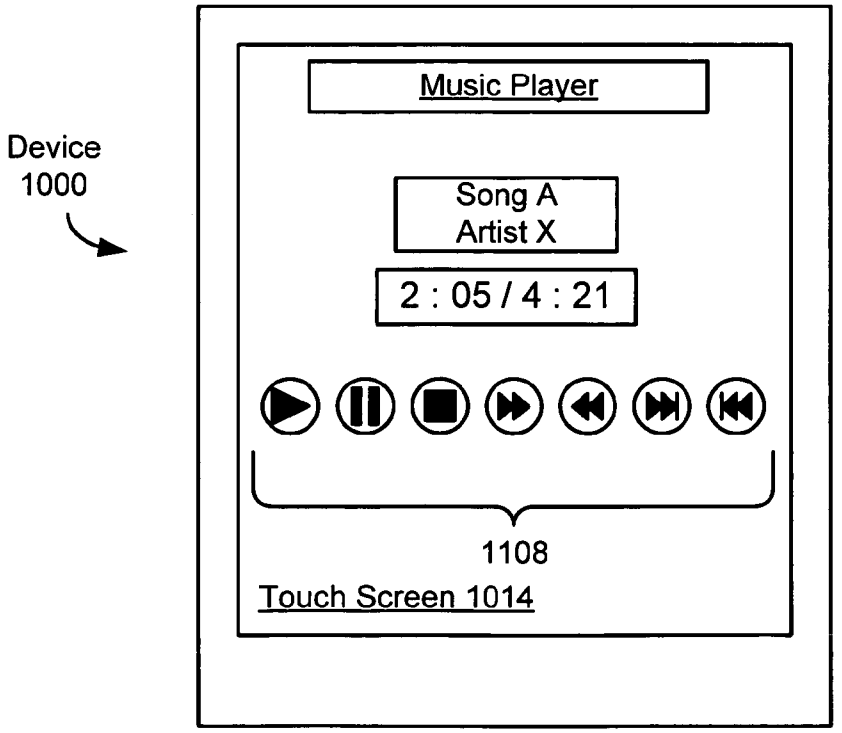


Figure 11F

UNLOCKING A DEVICE BY PERFORMING GESTURES ON AN UNLOCK IMAGE

RELATED APPLICATIONS

This application is related to U.S. patent application Ser. No. 11/322,550, titled "Indication of Progress Towards Satisfaction of a User Input Condition," filed Dec. 23, 2005, which application is incorporated by reference herein in its entirety.

TECHNICAL FIELD

The disclosed embodiments relate generally to user interfaces that employ touch-sensitive displays, and more particularly, to the unlocking of user interfaces on portable electronic devices.

BACKGROUND

Touch-sensitive displays (also known as "touch screens" or "touchscreens") are well known in the art. Touch screens are used in many electronic devices to display graphics and text, and to provide a user interface through which a user may interact with the devices. A touch screen detects and responds to contact on the touch screen. A device may display one or more soft keys, menus, and other user-interface objects on the touch screen. A user may interact with the device by contacting the touch screen at locations corresponding to the user-interface objects with which she wishes to interact.

Touch screens are becoming more popular for use as displays and as user input devices on portable devices, such as mobile telephones and personal digital assistants (PDAs). One problem associated with using touch screens on portable devices is the unintentional activation or deactivation of functions due to unintentional contact with the touch screen. Thus, portable devices, touch screens on such devices, and/or applications running on such devices may be locked upon satisfaction of predefined lock conditions, such as upon entering an active call, after a predetermined time of idleness has elapsed, or upon manual locking by a user.

Devices with touch screens and/or applications running on such devices may be unlocked by any of several well-known unlocking procedures, such as pressing a predefined set of buttons (simultaneously or sequentially) or entering a code or password. These unlock procedures, however, have drawbacks. The button combinations may be hard to perform. Creating, memorizing, and recalling passwords, codes, and the like can be quite burdensome. These drawbacks may reduce the ease of use of the unlocking process and, as a consequence, the ease of use of the device in general.

Accordingly, there is a need for more efficient, user-friendly procedures for unlocking such devices, touch screens, and/or applications. More generally, there is a need for more efficient, user-friendly procedures for transitioning such devices, touch screens, and/or applications between user interface states (e.g., from a user interface state for a first application to a user interface state for a second application, between user interface states in the same application, or between locked and unlocked states). In addition, there is a need for sensory feedback to the user regarding progress towards satisfaction of a user input condition that is required for the transition to occur.

SUMMARY

In some embodiments, a method of controlling an electronic device with a touch-sensitive display includes: detecting contact with the touch-sensitive display while the device is in a user-interface lock state; moving an image corresponding to a user-interface unlock state of the device in accordance with the contact; transitioning the device to the user-interface unlock state if the detected contact corresponds to a predefined gesture; and maintaining the device in the user-interface lock state if the detected contact does not correspond to the predefined gesture.

In some embodiments, a method of controlling a device with a touch-sensitive display includes: displaying an image on the touch-sensitive display while the device is in a user-interface lock state; detecting contact with the touch-sensitive display; transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the image to a predefined location on the touch-sensitive display; and maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the image to the predefined location.

In some embodiments, a method of controlling a device with a touch-sensitive display includes: displaying an image on the touch-sensitive display while the device is in a user-interface lock state; detecting contact with the touch-sensitive display; and transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the image on the touch-sensitive display according to a predefined path on the touch-sensitive display; and maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the image according to the predefined path.

In some embodiments, a method of controlling a device with a touch-sensitive display includes: displaying first and second images on the touch-sensitive display while the device is in a user-interface lock state; detecting contact with the touch-sensitive display; transitioning the device to a first active state corresponding to the first image if the detected contact corresponds to a predefined gesture with respect to the first image; and transitioning the device to a second active state distinct from the first active state if the detected contact corresponds to a predefined gesture with respect to the second image.

The aforementioned methods may be performed by a portable electronic device having a touch-sensitive display with a graphical user interface (GUI), one or more processors, memory and one or more modules, programs or sets of instructions stored in the memory for performing these methods. In some embodiments, the portable electronic device provides a plurality of functions, including wireless communication.

Instructions for performing the aforementioned methods may be included in a computer program product configured for execution by one or more processors. In some embodiments, the executable computer program product includes a computer readable storage medium (e.g., one or more magnetic disk storage devices, flash memory devices, or other non-volatile solid state memory devices) and an executable computer program mechanism embedded therein.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the aforementioned embodiments of the invention as well as additional embodiments thereof, reference should be made to the Description of Embodiments below, in conjunction with the following drawings in which like reference numerals refer to corresponding parts throughout the figures.

FIG. **1** is a block diagram illustrating a portable electronic device, according to some embodiments of the invention.

FIG. **2** is a flow diagram illustrating a process for transitioning a device to a user-interface unlock state, according to some embodiments of the invention.

FIG. **3** is a flow diagram illustrating a process for transitioning a device to a user-interface unlock state, according to some embodiments of the invention.

FIGS. **4**A-**4**B illustrate the GUI display of a device in a user-interface lock state, according to some embodiments of the invention.

FIGS. **5**A-**5**D illustrate the GUI display of a device at various points of the performance of an unlock action gesture, according to some embodiments of the invention.

FIG. **6** is a flow diagram illustrating a process for indicating progress towards satisfaction of a user input condition according to some embodiments of the invention.

FIGS. **7**A-**7**D illustrate the GUI display of a device that is transitioning the optical intensity of user-interface objects, according to some embodiments of the invention.

FIGS. **8**A-**8**C are graphs illustrating optical intensity as a function of the completion of the user input condition, according to some embodiments of the invention.

FIG. **9** is a flow diagram illustrating a process for transitioning a device to a user interface active state, according to some embodiments of the invention.

FIG. **10** illustrates the GUI of a device in a user-interface lock state that displays a plurality of unlock images, according to some embodiments of the invention.

FIGS. **11**A-**11**F illustrate the GUI display of a device at various points in the performance of an unlock action gesture, according to some embodiments of the invention.

DESCRIPTION OF EMBODIMENTS

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

FIG. **1** illustrates a portable electronic device, according to some embodiments of the invention. The device **100** includes a memory **102**, a memory controller **104**, one or more processing units (CPU's) **106**, a peripherals interface **108**, RF circuitry **112**, audio circuitry **114**, a speaker **116**, a microphone **118**, an input/output (I/O) subsystem **120**, a touch screen **126**, other input or control devices **128**, and an external port **148**. These components communicate over the one or more communication buses or signal lines **110**. The device **100** can be any portable electronic device, including but not limited to a handheld computer, a tablet computer, a mobile phone, a media player, a personal digital assistant (PDA), or the like, including a combination of two or more of these items. It should be appreciated that the device **100** is only one example of a portable electronic device **100**, and that the device **100** may have more or fewer components than shown, or a different configuration of components. The various components shown in FIG. **1** may be implemented in hardware, software or a combination of both hardware and software, including one or more signal processing and/or application specific integrated circuits.

The memory **102** may include high speed random access memory and may also include non-volatile memory, such as one or more magnetic disk storage devices, flash memory devices, or other non-volatile solid state memory devices. In some embodiments, the memory **102** may further include storage remotely located from the one or more processors **106**, for instance network attached storage accessed via the RF circuitry **112** or external port **148** and a communications network (not shown) such as the Internet, intranet(s), Local Area Networks (LANs), Wide Local Area Networks (WLANs), Storage Area Networks (SANs) and the like, or any suitable combination thereof. Access to the memory **102** by other components of the device **100**, such as the CPU **106** and the peripherals interface **108**, may be controlled by the memory controller **104**.

The peripherals interface **108** couples the input and output peripherals of the device to the CPU **106** and the memory **102**. The one or more processors **106** run various software programs and/or sets of instructions stored in the memory **102** to perform various functions for the device **100** and to process data.

In some embodiments, the peripherals interface **108**, the CPU **106**, and the memory controller **104** may be implemented on a single chip, such as a chip **111**. In some other embodiments, they may be implemented on separate chips.

The RF (radio frequency) circuitry **112** receives and sends electromagnetic waves. The RF circuitry **112** converts electrical signals to/from electromagnetic waves and communicates with communications networks and other communications devices via the electromagnetic waves. The RF circuitry **112** may include well-known circuitry for performing these functions, including but not limited to an antenna system, an RF transceiver, one or more amplifiers, a tuner, one or more oscillators, a digital signal processor, a CODEC chipset, a subscriber identity module (SIM) card, memory, and so forth. The RF circuitry **112** may communicate with the networks, such as the Internet, also referred to as the World Wide Web (WWW), an Intranet and/or a wireless network, such as a cellular telephone network, a wireless local area network (LAN) and/or a metropolitan area network (MAN), and other devices by wireless communication. The wireless communication may use any of a plurality of communications standards, protocols and technologies, including but not limited to Global System for Mobile Communications (GSM), Enhanced Data GSM Environment (EDGE), wideband code division multiple access (W-CDMA), code division multiple access (CDMA), time division multiple access (TDMA), Bluetooth, Wireless Fidelity (Wi-Fi) (e.g., IEEE 802.11a, IEEE 802.11b, IEEE 802.11g and/or IEEE 802.11n), voice over Internet Protocol (VoIP), Wi-MAX, a protocol for email, instant messaging, and/or Short Message Service (SMS)), or any other suitable communication protocol, including communication protocols not yet developed as of the filing date of this document.

The audio circuitry **114**, the speaker **116**, and the microphone **118** provide an audio interface between a user and the device **100**. The audio circuitry **114** receives audio data from the peripherals interface **108**, converts the audio data to an electrical signal, and transmits the electrical signal to the speaker **116**. The speaker converts the electrical signal to human-audible sound waves. The audio circuitry **114** also receives electrical signals converted by the microphone **116** from sound waves. The audio circuitry **114** converts the electrical signal to audio data and transmits the audio data to the peripherals interface **108** for processing. Audio data may be may be retrieved from and/or transmitted to the memory **102** and/or the RF circuitry **112** by the peripherals interface **108**. In some embodiments, the audio circuitry **114** also includes a headset jack (not shown). The headset jack provides an interface between the audio circuitry **114** and removable audio

input/output peripherals, such as output-only headphones or a headset with both output (headphone for one or both ears) and input (microphone).

The I/O subsystem **120** provides the interface between input/output peripherals on the device **100**, such as the touch screen **126** and other input/control devices **128**, and the peripherals interface **108**. The I/O subsystem **120** includes a touch-screen controller **122** and one or more input controllers **124** for other input or control devices. The one or more input controllers **124** receive/send electrical signals from/to other input or control devices **128**. The other input/control devices **128** may include physical buttons (e.g., push buttons, rocker buttons, etc.), dials, slider switches, sticks, and so forth.

The touch screen **126** provides both an output interface and an input interface between the device and a user. The touch-screen controller **122** receives/sends electrical signals from/to the touch screen **126**. The touch screen **126** displays visual output to the user. The visual output may include text, graphics, video, and any combination thereof. Some or all of the visual output may correspond to user-interface objects, further details of which are described below.

The touch screen **126** also accepts input from the user based on haptic and/or tactile contact. The touch screen **126** forms a touch-sensitive surface that accepts user input. The touch screen **126** and the touch screen controller **122** (along with any associated modules and/or sets of instructions in the memory **102**) detects contact (and any movement or break of the contact) on the touch screen **126** and converts the detected contact into interaction with user-interface objects, such as one or more soft keys, that are displayed on the touch screen. In an exemplary embodiment, a point of contact between the touch screen **126** and the user corresponds to one or more digits of the user. The touch screen **126** may use LCD (liquid crystal display) technology, or LPD (light emitting polymer display) technology, although other display technologies may be used in other embodiments. The touch screen **126** and touch screen controller **122** may detect contact and any movement or break thereof using any of a plurality of touch sensitivity technologies, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with the touch screen **126**. The touch-sensitive display may be analogous to the multi-touch sensitive tablets described in the following U.S. Pat. Nos. 6,323,846 (Westerman et al.), 6,570,557 (Westerman et al.), and/or 6,677,932 (Westerman), and/or U.S. Patent Publication 2002/0015024A1, each of which is hereby incorporated by reference. However, the touch screen **126** displays visual output from the portable device, whereas touch sensitive tablets do not provide visual output. The touch screen **126** may have a resolution in excess of 100 dpi. In an exemplary embodiment, the touch screen **126** may have a resolution of approximately 168 dpi. The user may make contact with the touch screen **126** using any suitable object or appendage, such as a stylus, finger, and so forth.

In some embodiments, in addition to the touch screen, the device **100** may include a touchpad (not shown) for activating or deactivating particular functions. In some embodiments, the touchpad is a touch-sensitive area of the device that, unlike the touch screen, does not display visual output. The touchpad may be a touch-sensitive surface that is separate from the touch screen **126** or an extension of the touch-sensitive surface formed by the touch screen **126**.

The device **100** also includes a power system **130** for powering the various components. The power system **130** may include a power management system, one or more power sources (e.g., battery, alternating current (AC)), a recharging system, a power failure detection circuit, a power converter or inverter, a power status indicator (e.g., a light-emitting diode (LED)) and any other components associated with the generation, management and distribution of power in portable devices.

In some embodiments, the software components include an operating system **132**, a communication module (or set of instructions) **134**, a contact/motion module (or set of instructions) **138**, a graphics module (or set of instructions) **140**, a user interface state module (or set of instructions) **144**, and one or more applications (or set of instructions) **146**.

The operating system **132** (e.g., Darwin, RTXC, LINUX, UNIX, OS X, WINDOWS, or an embedded operating system such as VxWorks) includes various software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) and facilitates communication between various hardware and software components.

The communication module **134** facilitates communication with other devices over one or more external ports **148** and also includes various software components for handling data received by the RF circuitry **112** and/or the external port **148**. The external port **148** (e.g., Universal Serial Bus (USB), FIREWIRE, etc.) is adapted for coupling directly to other devices or indirectly over a network (e.g., the Internet, wireless LAN, etc.).

The contact/motion module **138** detects contact with the touch screen **126**, in conjunction with the touch-screen controller **122**. The contact/motion module **138** includes various software components for performing various operations related to detection of contact with the touch screen **122**, such as determining if contact has occurred, determining if there is movement of the contact and tracking the movement across the touch screen, and determining if the contact has been broken (i.e., if the contact has ceased). Determining movement of the point of contact may include determining speed (magnitude), velocity (magnitude and direction), and/or an acceleration (including magnitude and/or direction) of the point of contact. In some embodiments, the contact/motion module **126** and the touch screen controller **122** also detects contact on the touchpad.

The graphics module **140** includes various known software components for rendering and displaying graphics on the touch screen **126**. Note that the term "graphics" includes any object that can be displayed to a user, including without limitation text, web pages, icons (such as user-interface objects including soft keys), digital images, videos, animations and the like.

In some embodiments, the graphics module **140** includes an optical intensity module **142**. The optical intensity module **142** controls the optical intensity of graphical objects, such as user-interface objects, displayed on the touch screen **126**. Controlling the optical intensity may include increasing or decreasing the optical intensity of a graphical object. In some embodiments, the increase or decrease may follow predefined functions.

The user interface state module **144** controls the user interface state of the device **100**. The user interface state module **144** may include a lock module **150** and an unlock module **152**. The lock module detects satisfaction of any of one or more conditions to transition the device **100** to a user-interface lock state and to transition the device **100** to the lock state. The unlock module detects satisfaction of any of one or more conditions to transition the device to a user-interface unlock state and to transition the device **100** to the unlock state. Further details regarding the user interface states are described below.

The one or more applications **130** can include any applications installed on the device **100**, including without limitation, a browser, address book, contact list, email, instant messaging, word processing, keyboard emulation, widgets, JAVA-enabled applications, encryption, digital rights management, voice recognition, voice replication, location determination capability (such as that provided by the global positioning system (GPS)), a music player (which plays back recorded music stored in one or more files, such as MP3 or AAC files), etc.

In some embodiments, the device **100** may include the functionality of an MP3 player, such as an iPod (trademark of Apple Computer, Inc.). The device **100** may, therefore, include a 36-pin connector that is compatible with the iPod. In some embodiments, the device **100** may include one or more optional optical sensors (not shown), such as CMOS or CCD image sensors, for use in imaging applications.

In some embodiments, the device **100** is a device where operation of a predefined set of functions on the device is performed exclusively through the touch screen **126** and, if included on the device **100**, the touchpad. By using the touch screen and touchpad as the primary input/control device for operation of the device **100**, the number of physical input/control devices (such as push buttons, dials, and the like) on the device **100** may be reduced. In one embodiment, the device **100** includes the touch screen **126**, the touchpad, a push button for powering the device on/off and locking the device, a volume adjustment rocker button and a slider switch for toggling ringer profiles. The push button may be used to turn the power on/off on the device by depressing the button and holding the button in the depressed state for a predefined time interval, or may be used to lock the device by depressing the button and releasing the button before the predefined time interval has elapsed. In an alternative embodiment, the device **100** also may accept verbal input for activation or deactivation of some functions through the microphone **118**.

The predefined set of functions that are performed exclusively through the touch screen and the touchpad include navigation between user interfaces. In some embodiments, the touchpad, when touched by the user, navigates the device **100** to a main, home, or root menu from any user interface that may be displayed on the device **100**. In such embodiments, the touchpad may be referred to as a "menu button." In some other embodiments, the menu button may be a physical push button or other physical input/control device instead of a touchpad.

User Interface States

The device **100** may have a plurality of user interface states. A user interface state is a state in which the device **100** responds in a predefined manner to user input. In some embodiments, the plurality of user interface states includes a user-interface lock state and a user-interface unlock state. In some embodiments, the plurality of user interface states includes states for a plurality of applications.

In the user-interface lock state (hereinafter the "lock state"), the device **100** is powered on and operational but ignores most, if not all, user input. That is, the device **100** takes no action in response to user input and/or the device **100** is prevented from performing a predefined set of operations in response to the user input. The predefined set of operations may include navigation between user interfaces and activation or deactivation of a predefined set of functions. The lock state may be used to prevent unintentional or unauthorized use of the device **100** or activation or deactivation of functions on the device **100**. When the device **100** is in the lock state, the device **100** may be said to be locked. In some embodiments, the device **100** in the lock state may respond to a limited set of user inputs, including input that corresponds to an attempt to transition the device **100** to the user-interface unlock state or input that corresponds to powering the device **100** off. In other words, the locked device **100** responds to user input corresponding to attempts to transition the device **100** to the user-interface unlock state or powering the device **100** off, but does not respond to user input corresponding to attempts to navigate between user interfaces. It should be appreciated that even if the device **100** ignores a user input, the device **100** may still provide sensory feedback (such as visual, audio, or vibration feedback) to the user upon detection of the input to indicate that the input will be ignored.

In embodiments where the device **100** includes the touch screen **126**, while the device **100** is locked, a predefined set of operations, such as navigation between user interfaces, is prevented from being performed in response to contact on the touch screen **126** when the device **100** is locked. In other words, when the contact is being ignored by the locked device **100**, the touch screen may be said to be locked. A locked device **100**, however, may still respond to a limited class of contact on the touch screen **126**. The limited class includes contact that is determined by the device **100** to correspond to an attempt to transition the device **100** to the user-interface unlock state.

In the user-interface unlock state (hereinafter the "unlock state"), the device **100** is in its normal operating state, detecting and responding to user input corresponding to interaction with the user interface. A device **100** that is in the unlock state may be described as an unlocked device **100**. An unlocked device **100** detects and responds to user input for navigating between user interfaces, entry of data and activation or deactivation of functions. In embodiments where the device **100** includes the touch screen **126**, the unlocked device **100** detects and responds to contact corresponding to navigation between user interfaces, entry of data and activation or deactivation of functions through the touch screen **126**.

Unlocking a Device via Gestures

FIG. **2** is a flow diagram illustrating a process **200** for transitioning a device to a user-interface unlock state, according to some embodiments of the invention. As used herein, transitioning from one state to another refers to the process of going from one state to another. The process may be, as perceived by the user, instantaneous, near-instantaneous, gradual or at any suitable rate. The progression of the process may be controlled automatically by the device, such as the device **100** (FIG. **1**), independent of the user, once the process is activated; or it may be controlled by the user. While the process flow **200** described below includes a number of operations that appear to occur in a specific order, it should be apparent that these processes may include more or fewer operations, which may be executed serially or in parallel (e.g., using parallel processors or a multi-threading environment).

A device is set to the lock state (**202**). The device may be set (that is, transition completely to the lock state from any other state) to the locked state upon satisfaction of any of one or more lock conditions. The lock conditions may include events such as the elapsing of a predefined time of inactivity, entry into an active call, or powering on the device. The lock conditions may also include user intervention, namely the user locking the device by a predefined user input. In some embodiments, the user may be allowed to specify the events that serve as lock conditions. For example, the user may

configure the device to transition to the lock state upon the elapsing of a predefined time of inactivity but not upon powering on the device.

In some embodiments, the locked device displays on the touch screen one or more visual cues of an unlock action that the user may perform to unlock the device (**204**). The visual cue(s) provide hints or reminders of the unlock action to the user. The visual cues may be textual, graphical or any combination thereof. In some embodiments, the visual cues are displayed upon particular events occurring while the device is locked. The particular events that trigger display of the visual cues may include an incoming call, incoming message, or some other event that may require the user's attention. In some embodiments, the visual cues may also be displayed upon particular user inputs, such as the user interacting with the menu button, the user making contact with the locked touch screen and/or the user interacting with any other input/control device. The locked device, when not displaying the visual cues, may power down the touch screen (which helps to conserve power) or display other objects on the touch screen, such as a screen saver or information that may be of interest to the user (e.g., battery charge remaining, date and time, network strength, etc.).

The unlock action includes contact with the touch screen. In some embodiments, the unlock action is a predefined gesture performed on the touch screen. As used herein, a gesture is a motion of the object/appendage making contact with the touch screen. For example, the predefined gesture may include a contact of the touch screen on the left edge (to initialize the gesture), a horizontal movement of the point of contact to the opposite edge while maintaining continuous contact with the touch screen, and a breaking of the contact at the opposite edge (to complete the gesture).

While the touch screen is locked, the user may initiate contact with the touch screen, i.e., touch the touch screen (**206**). For convenience of explanation, contact on the touch screen in the process **200** and in other embodiments described below will be described as performed by the user using at least one hand using one or more fingers. However, it should be appreciated that the contact may be made using any suitable object or appendage, such as a stylus, finger, etc. The contact may include one or more taps on the touch screen, maintaining continuous contact with the touch screen, movement of the point of contact while maintaining continuous contact, a breaking of the contact, or any combination thereof.

The device detects the contact on the touch screen (**208**). If the contact does not correspond to an attempt to perform the unlock action, or if the contact corresponds to a failed or aborted attempt by the user to perform the unlock action (**210**—no), then the device remains locked (**212**). For example, if the unlock action is a horizontal movement of the point of contact across the touch screen while maintaining continuous contact with the touch screen, and the detected contact is a series of random taps on the touch screen, then the device will remain locked because the contact does not correspond to the unlock action.

If the contact corresponds to a successful performance of the unlock action, i.e., the user performed the unlock action successfully (**210**—yes), the device transitions to the unlock state (**214**). For example, if the unlock action is a horizontal movement of the point of contact across the touch screen while maintaining continuous contact with the touch screen, and the detected contact is the horizontal movement with the continuous contact, then the device transitions to the unlock state.

In some embodiments, the device begins the process of transitioning to the unlock state upon detection of any contact on the touch screen and aborts the transition as soon as the device determines that the contact does not correspond to an unlock action or is a failed/aborted unlock action. For example, if the unlock action is a predefined gesture, the device may begin the process of transitioning to the unlock state as soon as it detects the initial contact of the gesture and continues the progression of the transition as the gesture is performed. If the user aborts the gesture before it is completed, the device aborts the transition and remains in the lock state. If the gesture is completed, the device completes the transition to the unlock state and becomes unlocked. As another example, if the unlock action is a horizontal movement of the point of contact across the touch screen while maintaining continuous contact with the touch screen, and the user taps the touch screen once, the device begins the process of the state transition as soon as it detects the tap but also aborts the process soon after because it realizes that the tap is just a tap and does not correspond to the unlock action.

While the device is unlocked, the device may display on the touch screen user-interface objects corresponding to one or more functions of the device and/or information that may be of interest to the user. The user-interface objects are objects that make up the user interface of the device and may include, without limitation, text, images, icons, soft keys (or "virtual buttons"), pull-down menus, radio buttons, check boxes, selectable lists, and so forth. The displayed user-interface objects may include non-interactive objects that convey information or contribute to the look and feel of the user interface, interactive objects with which the user may interact, or any combination thereof. The user may interact with the user-interface objects by making contact with the touch screen at one or more touch screen locations corresponding to the interactive objects with which she wishes to interact. The device detects the contact and responds to the detected contact by performing the operation(s) corresponding to the interaction with the interactive object(s).

While the device is locked, the user may still make contact on the touch screen. However, the locked device is prevented from performing a predefined set of actions in response to any detected contact until the device is unlocked. The prevented predefined set of action may include navigating between user interfaces and entry of data by the user.

While the device is locked, the device may display one or more visual cues of the unlock action, as described above. In some embodiments, the device may also display, along with the visual cues, an unlock image. The unlock image is a graphical, interactive user-interface object with which the user interacts in order to unlock the device. In other words, the unlock action is performed with respect to the unlock image. In some embodiments, performing the unlock action with respect to the image includes dragging the unlock image in a predefined manner, which moves the unlock image across the touch screen. In some embodiments, if the unlock action is not completed, the GUI display can show reverse progress towards the locked state by gradually returning the unlock image to its position in the locked state

In some embodiments, in addition to visual feedback, the electronic device supplies non-visual feedback to indicate progress towards completion of the unlock action. In some embodiments, in addition to visual feedback, the electronic device supplies non-visual feedback to indicate completion of the unlock action. The additional feedback may include audible feedback (e.g., sound(s)) or physical feedback (e.g., vibration(s)).

FIG. **3** is a flow diagram illustrating a process **300** for transitioning a device to a user-interface unlock state using an unlock image, according to some embodiments of the inven-

tion. The process **300** is similar to the process **200** (FIG. **2**) with the addition of an unlock image that is displayed with the visual cues. The unlock action in the process **300** is performed with respect to the unlock image, i.e., the unlock action includes interaction with the unlock image. While the process flow **300** described below includes a number of operations that appear to occur in a specific order, it should be apparent that these processes can include more or fewer operations, which can be executed serially or in parallel (e.g., using parallel processors or a multi-threading environment).

The device is locked upon satisfaction of a lock condition (**302**), similar to the operation **202** (FIG. **2**). An unlock image and visual cues of the unlock action using the unlock image are displayed (**304**). The operation **304** is the same as the operation **204** (FIG. **2**), except that in the operation **304** an unlock image is displayed in addition to the visual cues.

As described above, the unlock action includes interaction with the unlock image. In some embodiments, the unlock action includes the user performing a predefined gesture with respect to the unlock image. In some embodiments, the gesture includes dragging the unlock image to a location on the touch screen that meets one or more predefined unlock criteria. In other words, the user makes contact with the touch screen at a location corresponding to the unlock image and then performs the predefined gesture while maintaining continuous contact with the touch screen, dragging the image to the location that meets the predefined unlock criteria. In some embodiments, the unlock action is completed by breaking the contact with the touch screen (thus releasing the unlock image) upon completion of the predefined gesture.

A location meeting one or more predefined unlock criteria is simply a location on the touch screen that is predefined as a location to which the unlock image is to be dragged in order to unlock the device. The location(s) may be defined narrowly or broadly and may be one or more particular locations on the touch screen, one or more regions on the touch screen, or any combination thereof. For example, the location may be defined as a particular marked location, areas at each of the four corners of the touch screen, or a quadrant of the touch screen, etc.

In some embodiments, the interaction includes dragging the unlock image to a predefined location on the touch screen. For example, the unlock action may include dragging the unlock image from one corner of the touch screen to another corner of the touch screen. As another example, the unlock action may include dragging the unlock image from one edge of the touch screen to the opposite edge. The emphasis here is on the final destination of the unlock image (and of the finger) . Thus, the user can drag the unlock image from its initial location along any desired path. As long as the unlock image reaches the predefined location and is released at that location, the device is unlocked. It should be appreciated that the predefined location may be, as described above, defined narrowly or broadly and may be one or more particular locations on the touch screen, one or more regions on the touch screen, or any combination thereof.

In some other embodiments, the unlock action includes dragging the unlock image along a predefined path. For example, the unlock action may include dragging the unlock image clockwise along the perimeter of the touch screen (the path being the perimeter of the touch screen), from one of the corners and back. As another example, the unlock action may include dragging the unlock image from one edge of the touch screen to the opposite edge in a linear path. The emphasis here is on the path along which the unlock image (and the finger) moves. Because of the emphasis on the path, the final location to which the unlock image is to be moved may be defined broadly. For example, the unlock action may be to drag the unlock image from its initial location, along the predefined path, to any spot within a predefined region on the touch screen. The predefined path may include one or more straight lines or lines with twists and turns.

The user makes contact with the touch screen (**306**), similar to the operation **206** (FIG. **2**). The device detects the contact with the touch screen (**308**), similar to the operation **208** (FIG. **2**). If the contact does not correspond to successful performance of the unlock action with respect to the image (**310**—no), the device remains locked. If the contact does correspond to successful performance of the unlock action with respect to the image (**310**—yes), the device is unlocked (**314**).

FIGS. **4**A-**4**B illustrate the GUI display of a device in a user-interface lock state, according to some embodiments of the invention. In FIG. **4**A, device **400** includes a touch screen **408** and a menu button **410**. The device **400** is locked and the touch screen **408** is displaying an unlock image **402** and visual cues. The visual cues shown include a channel **404** indicating the path of the gesture/movement along which the unlock image **402** is to be dragged, similar to a groove along which a slider switch moves; and one or more arrows **406** indicating the direction of the gesture/movement. The end of the channel **404** (in FIGS. **4**A-**4**B and **5**A-**5**D, the "end" of the channel is the right end) also serves as a predefined location to which the unlock image **402** is to be dragged. The unlock image **402** may also include an arrow to further remind the user the direction of the gesture/movement. As described above, the visual cues and the unlock image may be displayed by the device **400** upon an event that may require the user's attention (e.g., incoming call or message) or upon user intervention (e.g., the user pressing the menu button **410** while the device is locked).

In some embodiments, the arrows **406** and the arrow on the unlock image **402** may be animated. For example, the arrow on the unlock image **402** may appear and disappear in a pulse-like manner and the arrows **406** may emanate from one end of the channel **406** in sync with the pulsing of the arrow on the unlock image **402**. As shown in FIG. **4**B, the arrow **406** may move along the channel **404** and disappear when it moves to the end of the channel **404**.

The visual cues illustrated in FIGS. **4**A and **4**B remind the user that the unlock action is a predefined gesture that includes a horizontal movement of the finger (and thus moving the point of contact) along the channel **404**, from the beginning of the channel **404**, where the unlock image is initially located, to the end of the channel **404**. It should be appreciated, however, that the visual cues shown in FIGS. **4**A-**4**B are merely exemplary and that more or fewer visual cues, or alternative visual cues may be used. The content of the visual cues may be based on the particulars of the unlock action.

FIGS. **5**A-**5**D illustrate the GUI display of a device at various points of the performance of an unlock action gesture, according to some embodiments of the invention. In FIG. **5**A, the user, represented by the hand and finger **502** (not drawn to scale), begins the unlock action by touching the touch screen **408** of device **400** with her finger **502**. In some embodiments, the touch screen **408** is initially in sleep mode and/or dark, and the screen **408** displays the unlock image **402** when touched. The user touches the touch screen **408** at the location corresponding to the unlock image **402**, which is located initially at the left end of the channel **404**. The contact, either overlapping with the unlock image **402** or in proximity to the unlock image **402**, is detected by the device **400** and is deter-

mined to be an attempt to unlock the touch screen, based on the fact that the user **502** is interacting with the unlock image **402**.

In FIG. **5**B, the user is in the process of performing the gesture by moving her finger, which is in continuous contact with the touch screen **408**, in the direction of movement **504**. The unlock image **402** is dragged along the channel **404** as a result of the gesture. The channel **404** reminds the user that the unlock gesture is a horizontal motion. In some embodiments, the channel **404** indicates the predefined location (in FIGS. **5**A-**5**D, the right end of the channel) to which the user drags the unlock image **402** to complete the unlock action and/or the predefined path along which the user drags the unlock image **402** to complete the unlock action.

In FIG. **5**C, the user has dragged the unlock image **402** to the right end of the channel **404**. Once the user releases the unlock image **402** at the right end of the channel **404**, the unlock action is complete. Upon completion of the unlock gesture, the device unlocks and displays on the touch screen **408** user-interface objects associated with normal operation of the device **400**. FIG. **5**D illustrates an example of user-interface objects that may be displayed when the device **400** is unlocked. In FIG. **5**D, the device **400** displays a menu **506**. The menu **506** includes interactive user-interface objects corresponding to various applications or operations. A user may interact with the user-interface objects to activate an application or perform an operation. It should be appreciated, however, that the device **400**, upon being unlocked, may display additional or alternative user-interface objects.

In some embodiments, the unlock image **402** may also be used to indicate failure of performance of the unlock action. For example, if the user breaks the contact with the touch screen before the unlock image reaches the right end of the channel **404**, the unlock action has failed. The device **400** may display the unlock image **402** returning to its initial position on the left end of the channel **404**, allowing the user to attempt the unlock action again, if she so chooses. In some embodiments, the device goes back to sleep if no gesture is applied in a predetermined period of time.

In some embodiments, the user may unlock the device **400** by contacting the touch screen **408** and moving the point of contact horizontally along a fraction of the channel **404**, i.e., the user need not move all the way to the right end of the channel. In some embodiments, the user may unlock the device **400** by making contact anywhere on the touch screen **408** and moving the point of contact horizontally as if he or she were following the channel **404**.

In some embodiments, the lock/unlock feature may apply to specific applications that are executing on the device **400** as opposed to the device **400** as a whole. In some embodiments, an unlock gesture transitions from one application to another, for example, from a telephone application to a music player or vice versa. The lock/unlock feature may include a hold or pause feature. In some embodiments, as the user transitions from a first application and to a second application, a user interface for the second application may fade in (i.e., increase in intensity) and a user interface for the first application may fade out (i.e., decrease in intensity). The fade in and fade out may occur smoothly over a pre-determined time interval, such as 0.2 s, 1 s or 2 s. The pre-determined time interval may be in accordance with the unlock gesture, such as the time it takes the user to perform the gesture.

Indication of Progress Towards Satisfaction of a User Input Condition

FIG. **6** is a flow diagram illustrating a process **600** for indicating progress towards satisfaction of a user input condition according to some embodiments of the invention. While the process flow **600** described below includes a number of operations that appear to occur in a specific order, it should be apparent that these processes can include more or fewer operations, which can be executed serially or in parallel (e.g., using parallel processors or a multi-threading environment).

While an electronic device is in a first user-interface state, progress is detected (**602**) towards satisfaction of a user input condition needed to transition to a second user-interface state. In some embodiments, the first user-interface state is for a first application and the second user-interface state is for a second application. In some embodiments, the first user-interface state is a lock state and the second user-interface state is an unlock state.

While the device is in the first user-interface state, progress is indicated (**604**) towards satisfaction of the condition by transitioning an optical intensity of one or more user interface objects associated with the second user-interface state. The change in optical intensity of the user-interface objects provides a user with sensory feedback of the progress in transitioning between user interface states.

In some embodiments, in addition to visual feedback, the device supplies non-visual feedback to indicate progress towards satisfaction of the user input condition. The additional feedback may include audible feedback (e.g., sound(s)) or physical feedback (e.g., vibration(s)).

The device transitions (**606**) to the second user-interface state if the condition is satisfied. In some embodiments, in addition to visual feedback, the device supplies non-visual feedback to indicate satisfaction of the user input condition. The additional feedback may include audible feedback (e.g., sound(s)) or physical feedback (e.g., vibration(s)).

The optical intensity of a user-interface object, as used herein, is the object's degree of visual materialization. The optical intensity may be measured along a scale between a predefined minimum and a predefined maximum. In some embodiments, the optical intensity may be measured along a logarithmic scale. In some embodiments, the optical intensity may be perceived by users as a transparency effect (or lack thereof) applied to the user-interface object. In some embodiments, the minimum optical intensity means that the object is not displayed at all (i.e., the object is not perceptible to the user), and the maximum optical intensity means that the object is displayed without any transparency effect (i.e., the object has completely materialized visually and is perceptible to the user). In some other embodiments, the optical intensity may be the visual differentiation between the user-interface object and the background, based on color, hue, color saturation, brightness, contrast, transparency, and any combination thereof.

In some embodiments, the optical intensity of the user-interface objects to be displayed in the second user-interface state is increased smoothly. Smoothly may include a transition time that is greater than a pre-defined threshold, for example, 0.2 s, 1 s or 2 s. The rate of the transition of the optical intensity may be any predefined rate.

In some embodiments, the indication of progress towards completion of the user input condition is a function of the user's satisfaction of the condition. For example, for a transition to an unlock state, the indication of progress towards completion is a function of the user's performance of an

unlock action. For a linear function, the indication of progress is 10% complete when the unlock action is 10% complete; the indication of progress is 50% complete when the unlock action is 50% complete, and so forth, up to 100% completion of the unlock action, at which point the transition to the unlock state occurs. Correspondingly, for a linear function, the transition of the optical intensity from an initial value to a final value is 10% complete when the unlock action is 10% complete; the transition is 50% complete when the unlock action is 50% complete, and so forth, up to 100% completion of the unlock action, at which point the optical intensity is at its final value. In some embodiments, the user may perceive the optical intensity transition as a fading in of the user-interface objects as the unlock action is performed. It should be appreciated that the function need not be linear and alternative functions may be used, further details of which are described below, in relation to FIGS. **8**A-**8**C.

If the user input condition includes a predefined gesture then the indication of progress of the gesture may be defined in terms of how much of the gesture is completed and how much of the gesture is remaining. For example, if the gesture includes moving the finger from one edge of the screen to the opposite edge horizontally, then the indication of progress may be defined in terms of the distance between the two edges because the distance remaining objectively measures how much further the user has to move her finger to complete the gesture.

If the user input condition includes dragging an image to a predefined location, then the indication of progress may be defined in terms of the distance between the initial location of the image and the predefined location to which the image is to be dragged in order to complete the input condition.

If the user input condition includes dragging an image along a predefined path, then the indication of progress may be defined in terms of the length of the predefined path.

FIGS. **7**A-**7**D illustrate the GUI display of a device that is transitioning the optical intensity of user-interface objects concurrent with a transition from a first user interface state to a second user interface state, according to some embodiments of the invention. In FIG. **7**A, the device **700** is locked and has received an incoming call. The device **700** is displaying a prompt **706** to the user, informing the user of the incoming call, on the touch screen **714**. The device is also displaying the unlock image **702** and channel **704** so that the user can unlock the device **700** in order to accept or decline the incoming call. The user begins the unlock action by making contact on the touch screen with her finger **710** on the unlock image **702**.

In FIG. **7**B, the user is in the process of dragging the unlock image **702** along the channel **704** in the direction of movement **712**. As the user drags the unlock image, a set of virtual buttons **708** appears and increases in optical intensity. The virtual buttons **708** are shown with dotted outlines to indicate that they are not yet at their final optical intensity levels. The virtual buttons **708** are associated with the prompt **706**; the virtual buttons shown in FIG. **7**B-**7**D allow the user to decline or accept the incoming call. However, the user cannot interact with the virtual buttons **708** until the device is unlocked and the virtual buttons have reached their final optical intensity. In FIG. **7**C, the user drags the unlock image **702** further along the channel **704** in the direction of movement **712**. The virtual buttons **708** have increased further in optical intensity relative to their optical intensity in FIG. **7**B, as illustrated by their different style of dotted outlines. The increases in optical intensity indicate to the user progress towards completion of the unlock action.

In FIG. **7**D, the user completes the unlock action by dragging the unlock image to the right end of the channel **704** and releasing the unlock image **702**. The device **700** transitions to the unlock state. The unlock image **702** and the channel **704** disappear from the display and the virtual buttons **708** are at their final optical intensity levels, as illustrated by their solid outlines. At this point the user may interact with the virtual buttons **708** and accept or decline the incoming call.

As described above in relation to FIGS. **5**A-**5**D, if the unlock action fails because the user releases the unlock image prematurely, the unlock image may return to its initial location. In some embodiments, the optical intensity of the virtual buttons **708** or other user-interface objects that were increasing in optical intensity as the unlock action was performed may, concurrent with the return of the unlock image to its initial location, have their optical intensity decreased smoothly, back to their initial levels.

FIGS. **8**A-**8**C are graphs illustrating optical intensity as a function of the completion of the user input condition, according to some embodiments of the invention. In FIG. **8**A, the optical intensity is a linear function of the completion of the user input condition. At 0% completion, the optical intensity is at an initial value (in this case, the initial value is 0). As the completion percentage increases, the optical intensity increases linearly with the completion percentage, until it reaches the final value at 100% completion.

In FIG. **8**B, the optical intensity is a nonlinear function of the completion of the user input condition. At 0% completion, the optical intensity is at an initial value (in this case, the initial value is 0). As the completion percentage increases, the optical intensity increases gradually at first, but the increase becomes steeper as the completion percentage increases, until it reaches the final value at 100% completion.

In FIG. **8**C, the optical intensity is another nonlinear function of the completion of the user input condition. At 0% completion, the optical intensity is at an initial value (in this case, the initial value is 0). As the completion percentage increases, the optical intensity increases steeply at first, but the increase becomes more gradual as the completion percentage increases, until it reaches the final value at 100% completion. In some embodiments, the optical intensity may increase according to a logarithmic scale.

In some embodiments, the optical intensity may reach its final value prior to 100% completion of the user input condition (e.g., at 90% completion).

User Interface Active States Corresponding to Events or Applications

FIG. **9** is a flow diagram illustrating a process **900** for transitioning a device to a user interface active state corresponding to one of a plurality of unlock images, according to some embodiments of the invention. In some embodiments, the device may have one or more active applications running when the device becomes locked. Additionally, while locked, the device may continue to receive events, such as incoming calls, messages, voicemail notifications, and so forth. The device may display multiple unlock images on the touch screen, each unlock image corresponding to an active application or incoming event. Performing the unlock action using one of the multiple unlock images unlocks the device and displays the application and/or event corresponding to the unlock image. The user interface active state, as used herein, means that the device is unlocked and a corresponding application or event is displayed on the touch screen to the user. While the process flow **900** described below includes a number of operations that appear to occur in a specific order, it should be apparent that these processes can include more or

fewer operations, which can be executed serially or in parallel (e.g., using parallel processors or a multi-threading environment).

The device is locked upon satisfaction of a predefined lock condition (**902**). The device may have active applications running when it is locked and the active applications may continue running while the device is locked. Additionally, while the device is locked, the device may receive events, such as incoming calls, messages, and voicemail notifications.

The device displays a plurality of unlock images, each displayed unlock image corresponding to an active application running or an event received while the device is locked (**904**). In some embodiments, the device also displays visual cues of the unlock action with respect to each unlock image. The device may display additional unlock images and visual cues as additional events are received. The user makes contact with the touch screen (**906**). The device detects the contact gesture (**908**). If the detected contact gesture does not correspond to successful performance of the unlock action with respect to any one of the displayed unlock images (e.g., because the contact is not an attempt to perform the unlock action or the unlock action failed/was aborted) (**910**—no), the device remains locked (**912**). If the detected contact gesture does correspond to successful performance of the unlock action with respect to one of the displayed unlock images (**910**—yes), the touch screen is unlocked and the running application or event corresponding to the one of the unlock images is displayed on the touch screen (**914**). In other words, the device transitions to a first active state corresponding to the first image if the detected contact corresponds to a predefined gesture with respect to the first image; the device transitions to a second active state distinct from the first active state and corresponding to the second image if the detected contact corresponds to a predefined gesture with respect to the second image; and so on.

The device becomes unlocked and makes the corresponding event or application visible to the user, active, or running in the foreground, as opposed to running in the background, upon performance of the unlock action with respect to the particular unlock image. The user-interface active state includes the running application or incoming event corresponding to the particular unlock image with which the user interacted being displayed prominently on the touch screen, in addition to the device being unlocked. Thus, unlocking using a first unlock image (if multiple unlock images are displayed) transitions the device to a first user-interface active state, in which the device is unlocked and the application/event corresponding to the first unlock image is displayed prominently. Unlocking using a second image transitions the device to a second user-interface active state, in which the device is unlocked and the application/event corresponding to the second unlock image is displayed prominently.

In some embodiments, the device may prioritize which unlock images to display. The device may display a subset of the corresponding unlock images on the touch screen at one time. The device may decide which subset to display based on one or more predefined criteria. For example, the device may display only unlock images corresponding to the most recent events and/or running applications. As another example, the device may display only unlock images corresponding to incoming events.

FIG. **10** illustrates the GUI of a device **1000** in a user-interface lock state that displays a plurality of unlock images, according to some embodiments of the invention. In FIG. **10**, the touch screen **1014** of the device **1000** is locked. A first unlock image **1002** is displayed with corresponding visual cues, such as the first channel **1004** and arrow **1006**. A second unlock image **1008** is displayed with corresponding visual cues, such as the second channel **1010** and arrow **1012**. The touch screen **1014** may display additional unlock images and visual cues. The first unlock image **1002** corresponds to a first running application or received event. The second unlock image **1008** corresponds to a second running application or received event. The first and second unlock images and visual cues are similar to the unlock image and visual cues described above, in relation to FIGS. **4**A and **4**B. The arrows **1006** and **1012** may be animated to move from one end of the channels **1004** and/or **1010** to the other end, in order to indicate the proper direction of the predefined gesture or movement of the unlock image.

FIGS. **11**A-**11**F illustrate the GUI display of a device at various points in the performance of an unlock action gesture corresponding to one of a plurality of unlock images, according to some embodiments of the invention. In FIG. **11**A, the user makes contact with the touch screen **1014** using her finger **1102** (not shown to scale), at the location corresponding to the second unlock image **1008**. The user performs the unlock action gesture by moving the point of contact, dragging the second unlock image **1008**. FIG. **11**B shows a snapshot of the device **1000** during the pendency of the unlock action. The second unlock image **1008** is moved along in the channel **1010** in the direction of movement **1104**.

FIG. **11**C shows the second unlock image **1008** moved to the end of the channel **1010**, where the unlock action with respect to the second unlock image **1008** will be completed once the user breaks the contact (and releases the second unlock image **1008**). In some embodiments, the unlock action is completed when the unlock image **1008** is moved to the end of the channel **1010**, with or without the user breaking contact, and the second unlock image **1008** disappears. As shown in FIG. **11**D, upon completion of the unlock action with respect to the second unlock image **1008**, the device displays on the touch screen the user-interface objects **1106** associated with the application or event corresponding to the second unlock image **1008**. In FIG. **11**D, the event corresponding to the second unlock image is an incoming text message event and a prompt for the user to read it.

The user, instead of performing the unlock action with respect to the second unlock image **1108**, may instead perform the unlock action gesture with respect to the first unlock image **1002**. In FIG. **11**E, the user does so and performs the unlock action with respect to the first unlock image **1002** by dragging the first unlock image, in the direction **1104**, to the right end of the channel **1004**. Upon completion of the unlock action, the device **1000** displays the user-interface objects **1108** associated with the application or event corresponding to the first unlock image **1002**. In FIG. **11**F, the application corresponding to the first unlock image is a music player application.

In some embodiments, the transition to a user interface active state, as described in FIGS. **9** and **11**A-**11**E, may also include a concurrent transition in the optical intensity of user-interface objects, similar to that described above in relation to FIGS. **6**, **7**A-**7**D, and **8**A-**8**C. Concurrent with the transition to a user interface active state, the user-interface objects associated with the application or event corresponding to the unlock image with which the user interacted to unlock the device increase in intensity. For example, the optical intensity of the user-interface objects **1106** associated with the text message prompt in FIG. **11**D may be increased smoothly, as a function of the progress towards completion of the unlock action with respect to the second unlock image **1008**. As another example, the optical intensity of the user-

interface objects **1108** associated with music player application in FIG. **11**F may be increased smoothly, as a function of the progress towards completion of the unlock action with respect to the first unlock image **1002**.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A method of controlling an electronic device with a touch-sensitive display, comprising:

detecting contact with the touch-sensitive display while the device is in a user-interface lock state;

moving an unlock image along a predefined displayed path on the touch-sensitive display in accordance with the contact, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

transitioning the device to a user-interface unlock state if the detected contact corresponds to a predefined gesture; and

maintaining the device in the user-interface lock state if the detected contact does not correspond to the predefined gesture.

2. The method of claim **1**, further comprising, while the device is in the user-interface lock state, preventing the device from performing a predefined set of actions in response to detecting any contact with the touch-sensitive display that does not correspond to the predefined gesture.

3. The method of claim **1**, wherein the predefined displayed path is a channel.

4. The method of claim **1**, wherein the detected contact is a movement of a point of contact across the touch-sensitive display while maintaining continuous contact with the touch-sensitive display.

5. The method of claim **4**, wherein the movement of the point of contact across the touch-sensitive display while maintaining continuous contact with the touch-sensitive display is a horizontal movement.

6. A method of controlling a device comprising a touch-sensitive display, comprising:

displaying an unlock image on the touch-sensitive display while the device is in a user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

detecting contact with the touch-sensitive display;

transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image along a predefined displayed path on the touch-sensitive display to a predefined location on the touch-sensitive display; and

maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image along the predefined displayed path on the touch-sensitive display to the predefined location.

7. The method of claim **6**, further comprising, while the device is in the user-interface lock state, preventing the device from performing a predefined set of actions in response to detecting any contact with the touch-sensitive display that does not correspond to moving the unlock image along the predefined displayed path on the touch-sensitive display to the predefined location.

8. A method of controlling a device comprising a touch-sensitive display, comprising:

displaying an unlock image on the touch-sensitive display while the device is in a user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

detecting contact with the touch-sensitive display; and

transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image across the touch-sensitive display according to a predefined displayed path on the touch-sensitive display; and

maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image across the touch-sensitive display according to the predefined displayed path.

9. The method of claim **8**, further comprising, while the device is in a user-interface lock state, preventing the device from performing a predefined set of actions in response to detecting any contact with the touch-sensitive display that does not correspond to moving the unlock image across the touch-sensitive display according to the predefined displayed path.

10. The method of claim **8**, wherein the detected contact corresponding to moving the unlock image across the touch-sensitive display according the predefined displayed path comprises contact corresponding to moving the unlock image across the touch-sensitive display to an endpoint of the predefined displayed path.

11. A method of controlling a device comprising a touch-sensitive display, comprising:

displaying a first unlock image and a second unlock image on the touch-sensitive display while the device is in a user-interface lock state;

detecting contact with the touch-sensitive display;

transitioning the device to a first active state corresponding to the first unlock image if the detected contact corresponds to a predefined gesture with respect to the first unlock image that moves the first unlock image along a first predefined displayed path on the touch sensitive display; and

transitioning the device to a second active state distinct from the first active state if the detected contact corresponds to a predefined gesture with respect to the second unlock image that moves the second unlock image along a second predefined displayed path on the touch-sensitive display.

12. A portable electronic device, comprising:

a touch-sensitive display;

memory;

one or more processors; and

one or more modules stored in the memory and configured for execution by the one or more processors, the one or more modules including instructions:

to set the device to a user-interface lock state;

to display an unlock image on the touch-sensitive display while the device is in the user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

to detect contact with the touch-sensitive display;

to move the unlock image along a predefined displayed path on the touch-sensitive display in accordance with the contact;

to transition the device to a user-interface unlock state if the detected contact corresponds to a predefined gesture; and

to maintain the device in the user-interface lock state if the detected contact does not correspond to the predefined gesture.

13. A portable electronic device, comprising:

a touch-sensitive display;

memory;

one or more processors; and

one or more modules stored in the memory and configured for execution by the one or more processors, the one or more modules including instructions:

to set the device to a user-interface lock state;

to display an unlock image on the touch-sensitive display while the device is in the user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

to detect contact with the touch-sensitive display;

to transition the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image along a predefined displayed path on the touch-sensitive display to a predefined location on the touch-sensitive display; and

to maintain the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image along the predefined displayed path on the touch-sensitive display to the predefined location.

14. A portable electronic device, comprising:

a touch-sensitive display;

memory;

one or more processors; and

one or more modules stored in the memory and configured for execution by the one or more processors, the one or more modules including instructions:

to set the device to a user-interface lock state;

to display an unlock image on the touch-sensitive display while the device is in the user-interface lock state;

to detect contact with the touch-sensitive display;

to transition the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image across the touch-sensitive display according to a predefined displayed path on the touch-sensitive display; and

to maintain the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image across the touch-sensitive display according to the predefined displayed path.

15. A portable electronic device, comprising:

a touch sensitive display;

memory;

one or more processors;

one or more modules stored in the memory and configured for execution by the one or more processors, the one or more processors including instructions:

to set the device to a user-interface lock state;

to display a first unlock image and a second unlock image on the touch-sensitive display;

to detect contact with the touch-sensitive display;

to transition the device to a first active state corresponding to the first unlock image if the detected contact corresponds to a predefined gesture with respect to the first unlock image that moves the first unlock image along a first predefined displayed path on the touch-sensitive display; and

to transition the device to a second active state distinct from the first active state if the detected contact corresponds to a predefined gesture with respect to the second unlock image that moves the second unlock image along a second predefined displayed path on the touch-sensitive display.

16. A portable electronic device, comprising:

a touch-sensitive display;

means for detecting contact with the touch-sensitive display while the device is in a user-interface lock state;

means for moving an unlock image along a predefined displayed path on the touch-sensitive display in accordance with the contact, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

means for transitioning the device to the user-interface unlock state if the detected contact corresponds to a predefined gesture; and

means for maintaining the device in the user-interface lock state if the detected contact does not correspond to the predefined gesture.

17. A portable electronic device, comprising:

a touch-sensitive display;

means for displaying an unlock image on the touch-sensitive display while the device is in a user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

means for detecting contact with the touch-sensitive display;

means for transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image along a predefined displayed path on the touch-sensitive display to a predefined location on the touch-sensitive display; and

means for maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image along the predefined displayed path on the touch-sensitive display to the predefined location.

18. A portable electronic device, comprising:

a touch-sensitive display;

means for displaying an unlock image on the touch-sensitive display while the device is in a user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

means for detecting contact with the touch-sensitive display; and

means for transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image across the touch-sensitive display according to a predefined displayed path on the touch-sensitive display; and

means for maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image across the touch-sensitive display according to the predefined displayed path.

19. A portable electronic device, comprising:

a touch-sensitive display;

means for displaying a first unlock image and a second unlock image on the touch-sensitive display while the device is in a user-interface lock state;

means for detecting contact with the touch-sensitive display;

means for transitioning the device to a first active state corresponding to the first unlock image if the detected contact corresponds to a predefined gesture with respect to the first unlock image that moves the first unlock image along a first predefined displayed oath on the touch-sensitive display; and

means for transitioning the device to a second active state distinct from the first active state if the detected contact corresponds to a predefined gesture with respect to the second unlock image that moves the second unlock image along a second predefined displayed oath on the touch-sensitive display.

20. A computer program product for use in conjunction with a portable electronic device comprising a touch-sensitive display, the computer program product comprising a computer readable storage medium and an executable computer program mechanism embedded therein, the executable computer program mechanism comprising instructions for:

detecting contact with the touch-sensitive display while the device is in a user-interface lock state;

moving an unlock image along a predefined displayed path on the touch-sensitive display in accordance with the contact, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

transitioning the device to the user-interface unlock state if the detected contact corresponds to a predefined gesture; and

maintaining the device in the user-interface lock state if the detected contact does not correspond to the predefined gesture.

21. A computer program product for use in conjunction with a portable electronic device comprising a touch-sensitive display, the computer program product comprising a computer readable storage medium and an executable computer program mechanism embedded therein, the executable computer program mechanism comprising instructions for:

displaying an unlock image on the touch-sensitive display while the device is in a user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

detecting contact with the touch-sensitive display;

transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image along a predefined displayed path on the touch-sensitive display to a predefined location on the touch-sensitive display; and

maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image along the predefined displayed path on the touch-sensitive display to the predefined location.

22. A computer program product for use in conjunction with a portable electronic device comprising a touch-sensitive display, the computer program product comprising a computer readable storage medium and an executable computer program mechanism embedded therein, the executable computer program mechanism comprising instructions for:

displaying an unlock image on the touch-sensitive display while the device is in a user-interface lock state, wherein the unlock image is a graphical, interactive user-interface object with which a user interacts in order to unlock the device;

detecting contact with the touch-sensitive display; and

transitioning the device to a user-interface unlock state if the detected contact corresponds to moving the unlock image across the touch-sensitive display according to a predefined displayed path on the touch-sensitive display; and

maintaining the device in the user-interface lock state if the detected contact does not correspond to moving the unlock image across the touch-sensitive display according to the predefined displayed path.

23. A computer program product for use in conjunction with a portable electronic device comprising a touch-sensitive display, the computer program product comprising a computer readable storage medium and an executable computer program mechanism embedded therein, the executable computer program mechanism comprising instructions for:

displaying a first unlock image and a second unlock image on the touch-sensitive display while the device is in a user-interface lock state;

detecting contact with the touch-sensitive display;

transitioning the device to a first active state corresponding to the first unlock image if the detected contact corresponds to a predefined gesture with respect to the first unlock image that moves the first unlock image along a first predefined displayed oath on the touch-sensitive display; and

transitioning the device to a second active state distinct from the first active state if the detected contact corresponds to a predefined gesture with respect to the second unlock image that moves the second unlock image along a second predefined displayed oath on the touch-sensitive display.

* * * * *

EXHIBIT D

US007469381B2

(12) **United States Patent**
Ording

(10) **Patent No.: US 7,469,381 B2**
(45) **Date of Patent: Dec. 23, 2008**

(54) **LIST SCROLLING AND DOCUMENT TRANSLATION, SCALING, AND ROTATION ON A TOUCH-SCREEN DISPLAY**

(75) Inventor: **Bas Ording**, San Francisco, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **11/956,969**

(22) Filed: **Dec. 14, 2007**

(65) **Prior Publication Data**

US 2008/0168404 A1 Jul. 10, 2008

Related U.S. Application Data

(60) Provisional application No. 60/937,993, filed on Jun. 29, 2007, provisional application No. 60/946,971, filed on Jun. 28, 2007, provisional application No. 60/945,858, filed on Jun. 22, 2007, provisional application No. 60/879,469, filed on Jan. 8, 2007, provisional application No. 60/883,801, filed on Jan. 7, 2007, provisional application No. 60/879,253, filed on Jan. 7, 2007.

(51) **Int. Cl.**
G06F 3/01 (2006.01)

(52) **U.S. Cl.** **715/702**; 715/764; 715/863; 715/864; 715/769

(58) **Field of Classification Search** 715/764, 715/769, 702, 863, 864
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,495,566	A	2/1996	Kwatinetz	395/157
5,844,547	A	12/1998	Minakuchi et al.	345/173
5,867,158	A	2/1999	Murasaki et al.	345/341
6,034,688	A	3/2000	Greenwood et al.	345/353
6,489,951	B1	12/2002	Wong et al.	345/173
6,567,102	B2	5/2003	Kung	345/660

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0 635 779	A1	1/1995

(Continued)

OTHER PUBLICATIONS

Microsoft Word 2003 Screen Shots.*

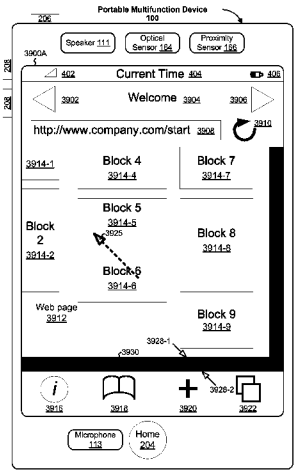
(Continued)

Primary Examiner—Boris Pesin
(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

In accordance with some embodiments, a computer-implemented method for use in conjunction with a device with a touch screen display is disclosed. In the method, a movement of an object on or near the touch screen display is detected. In response to detecting the movement, an electronic document displayed on the touch screen display is translated in a first direction. If an edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display, an area beyond the edge of the document is displayed. After the object is no longer detected on or near the touch screen display, the document is translated in a second direction until the area beyond the edge of the document is no longer displayed.

20 Claims, 38 Drawing Sheets



U.S. PATENT DOCUMENTS

6,661,409	B2	12/2003	Demartines et al.	345/173
6,690,387	B2 *	2/2004	Zimmerman et al.	345/684
6,707,449	B2	3/2004	Hinckley et al.	345/173
6,809,724	B1	10/2004	Shiraishi et al.	345/169
6,907,575	B2	6/2005	Duarte	715/784
6,912,462	B2	6/2005	Ogaki	701/208
6,972,776	B2	12/2005	Davis et al.	345/684
6,975,306	B2	12/2005	Hinckley et al.	345/173
7,009,599	B2	3/2006	Pihlaja	345/173
7,046,230	B2	5/2006	Zadesky et al.	345/156
7,075,512	B1	7/2006	Fabre et al.	345/156
7,102,626	B2	9/2006	Denny, III	345/179
7,154,534	B2	12/2006	Seki et al.	348/207.1
7,155,048	B2	12/2006	Ohara	382/132
7,181,373	B2	2/2007	Le Cocq et al.	703/1
7,184,796	B2	2/2007	Karidis et al.	455/566
7,240,291	B2	7/2007	Card et al.	715/776
2003/0095135	A1	5/2003	Kaasila et al.	345/613
2003/0095697	A1	5/2003	Wood et al.	382/131
2003/0184525	A1	10/2003	Tsai	345/173
2004/0021676	A1	2/2004	Chen et al.	345/684
2004/0027398	A1 *	2/2004	Jaeger	345/863
2004/0080541	A1	4/2004	Saiga et al.	345/805
2004/0155888	A1	8/2004	Padgitt et al.	345/619
2004/0263486	A1	12/2004	Seni	345/173
2005/0012723	A1	1/2005	Pallakoff	345/173
2005/0145807	A1	7/2005	Lapstun et al.	250/566
2005/0168488	A1	8/2005	Montague	345/659
2005/0198588	A1	9/2005	Lin et al.	715/784
2005/0237308	A1	10/2005	Autio et al.	345/173
2005/0270269	A1	12/2005	Tokkonen	345/156
2005/0275618	A1	12/2005	Juh et al.	345/156
2006/0025218	A1	2/2006	Hotta	463/37
2006/0026521	A1	2/2006	Hotelling et al.	715/702
2006/0048073	A1	3/2006	Jarrett et al.	715/784
2006/0055669	A1	3/2006	Das	345/156
2006/0061551	A1	3/2006	Fateh	345/158
2006/0077544	A1	4/2006	Stark	359/448
2006/0082549	A1	4/2006	Hoshino et al.	345/157
2006/0094502	A1	5/2006	Katayama et al.	463/31
2006/0156249	A1	7/2006	Blythe et al.	715/781
2006/0181510	A1	8/2006	Faith	345/158
2006/0187215	A1	8/2006	Rosenberg et al.	345/173
2006/0197753	A1	9/2006	Hotelling	345/173
2006/0238495	A1	10/2006	Davis	345/156
2007/0008066	A1	1/2007	Fukuda	340/5.52
2007/0024646	A1	2/2007	Saarinen et al.	345/660
2007/0046646	A1	3/2007	Kwon et al.	345/173
2007/0067745	A1	3/2007	Choi et al.	715/863
2007/0109275	A1	5/2007	Chuang	345/173
2007/0120835	A1	5/2007	Sato	345/173
2007/0150826	A1	6/2007	Anzures et al.	715/772
2007/0150842	A1	6/2007	Chaudhri et al.	715/863
2007/0152978	A1	7/2007	Kocienda et al.	345/173
2007/0152979	A1	7/2007	Jobs et al.	345/173
2007/0155434	A1	7/2007	Jobs et al.	455/565
2007/0156364	A1	7/2007	Rothkopf	702/117
2008/0104544	A1 *	5/2008	Collins et al.	715/846

FOREIGN PATENT DOCUMENTS

EP	0 701 220	A	3/1996
EP	0 880 091	A2	11/1998
WO	WO 02/01338	A1	1/2002
WO	WO 03/060622	A2	7/2003
WO	WO 2005/052773	A2	6/2005
WO	WO 2006/003591	A	1/2006
WO	WO 2006/020305	A2	2/2006

OTHER PUBLICATIONS

Photo Mesa 3.1.2 2006 Screen Shots.*

International Search Report and Written Opinion for International Application No. PCT/US2008/050292, mailed Sep. 19, 2008.

IBM, "Scroll Control Box," IBM Technical Disclosure Bulletin, vol. 38, No. 04, Apr. 1993, pp. 399-403.

Tidwell et al., "Magnetism," Designing Interfaces, Nov. 2005, Section 85.

Invitation to Pay Additional Fees for International Application No. PCT/US2008/050292, mailed Jul. 18, 2008.

Miller, D., "PersonalJava Application Environment," Sun Microsystems, http://java.sun.com/products/personaljava/touchable/, Jun. 8, 1999, 13 pages.

* cited by examiner

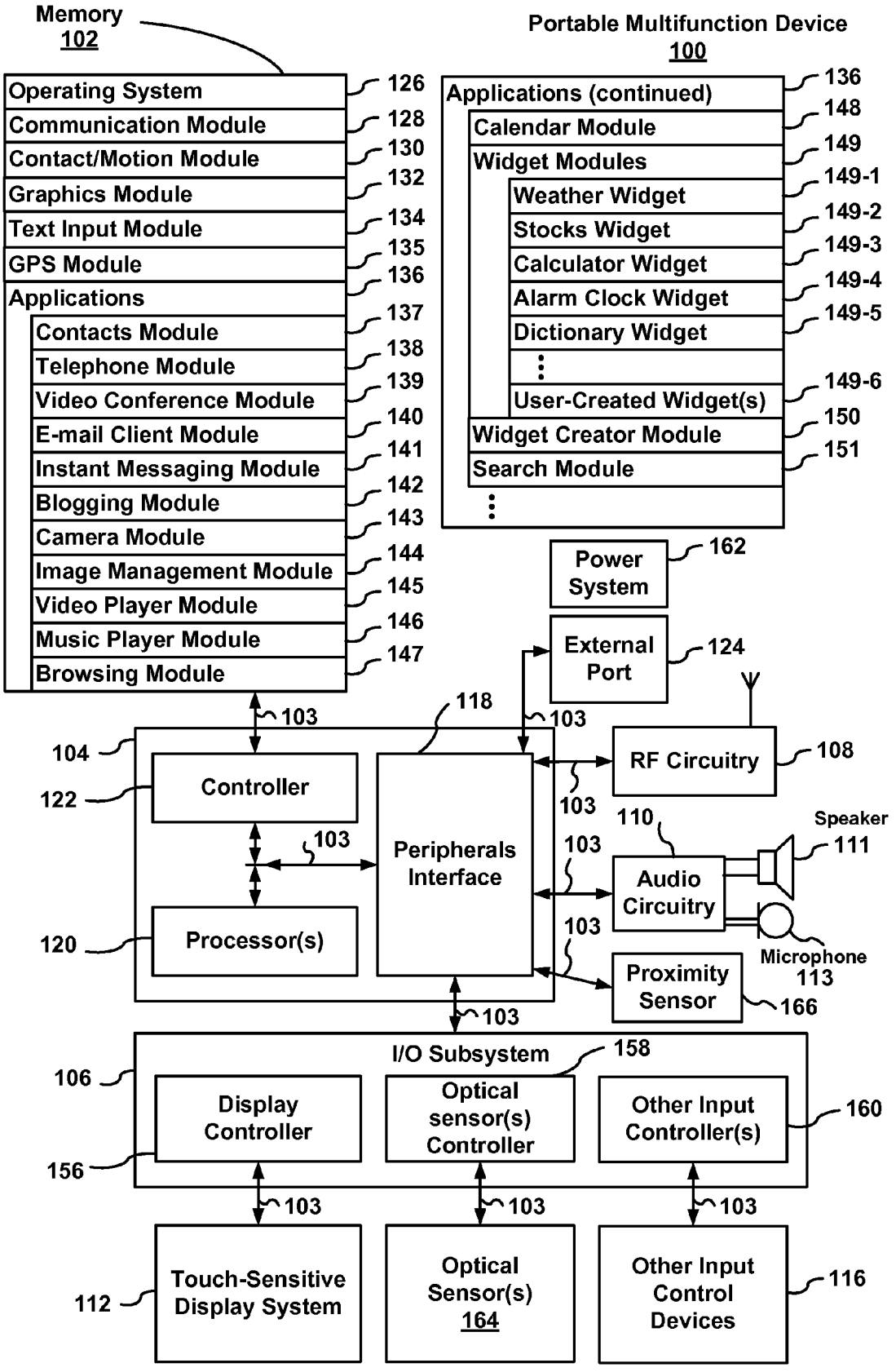

Memory
102
Portable Multifunction Device
100
Operating System
126
Communication Module
128
Contact/Motion Module
130
Graphics Module
132
Text Input Module
134
GPS Module
135
Applications
136
Contacts Module
137
Telephone Module
138
Video Conference Module
139
E-mail Client Module
140
Instant Messaging Module
141
Blogging Module
142
Camera Module
143
Image Management Module
144
Video Player Module
145
Music Player Module
146
Browsing Module
147
Applications (continued)
136
Calendar Module
148
Widget Modules
149
Weather Widget
149-1
Stocks Widget
149-2
Calculator Widget
149-3
Alarm Clock Widget
149-4
Dictionary Widget
149-5
User-Created Widget(s)
149-6
Widget Creator Module
150
Search Module
151
Power System
162
External Port
124
103
118
104
Controller
122
Peripherals Interface
RF Circuitry
108
Speaker
111
110
Audio Circuitry
Microphone
113
Proximity Sensor
166
120
Processor(s)
I/O Subsystem
158
106
Display Controller
Optical sensor(s) Controller
Other Input Controller(s)
160
156
Touch-Sensitive Display System
112
Optical Sensor(s)
164
Other Input Control Devices
116

Figure 1

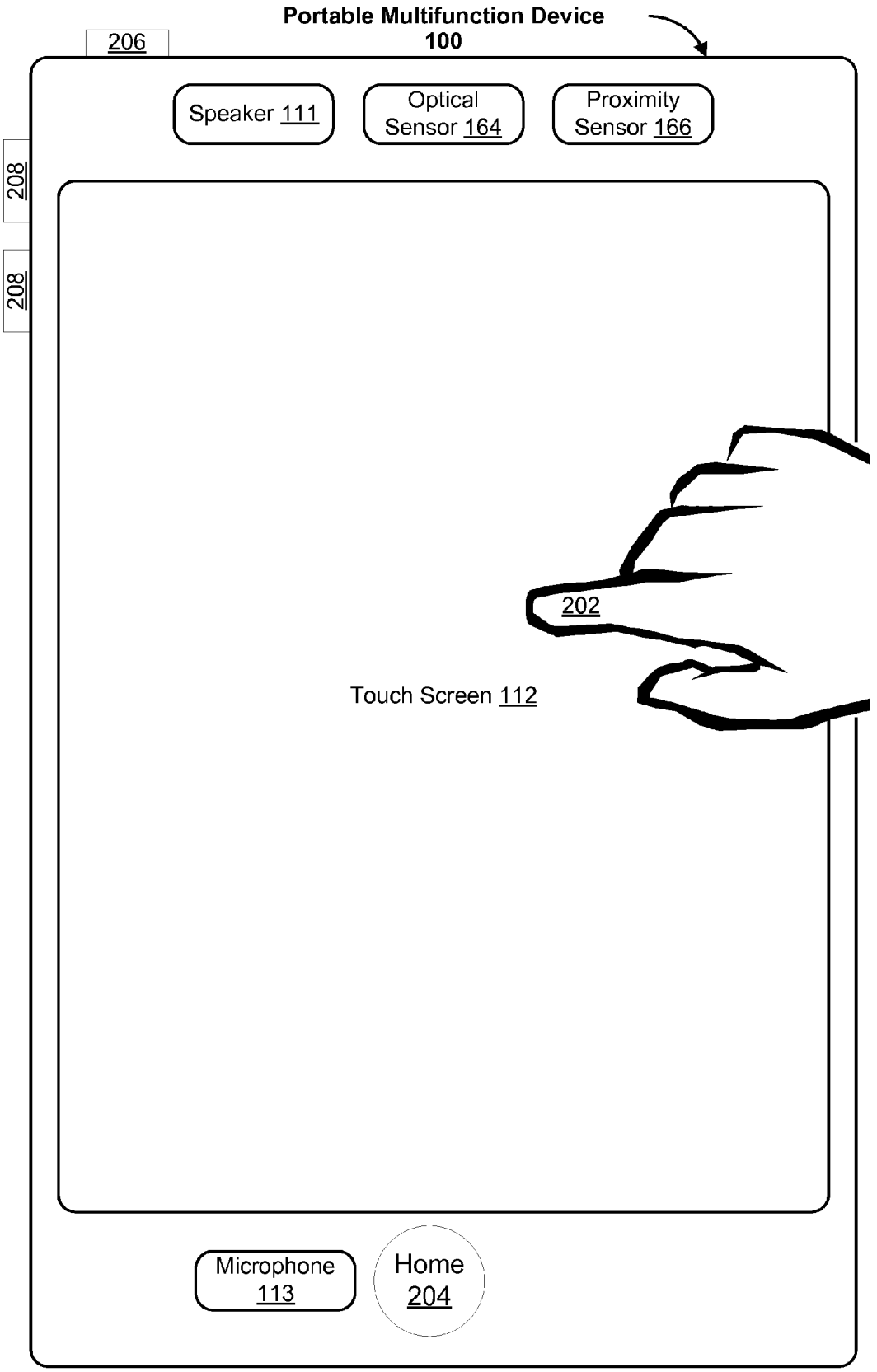

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
208
208
202
Touch Screen 112
Microphone 113
Home 204

Figure 2

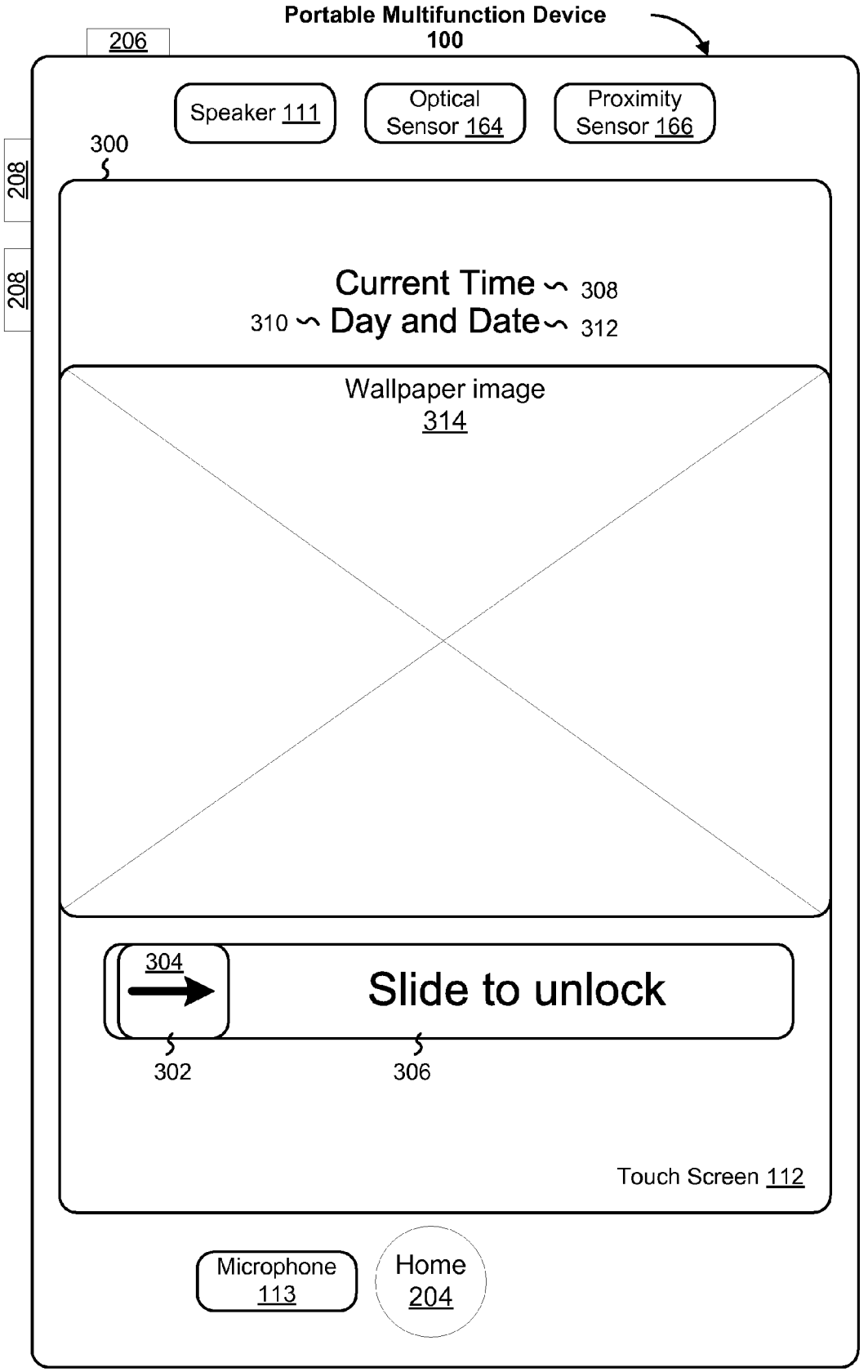

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
300
208
208
Current Time 308
310 Day and Date 312
Wallpaper image
314
304
Slide to unlock
302
306
Touch Screen 112
Microphone 113
Home 204

Figure 3

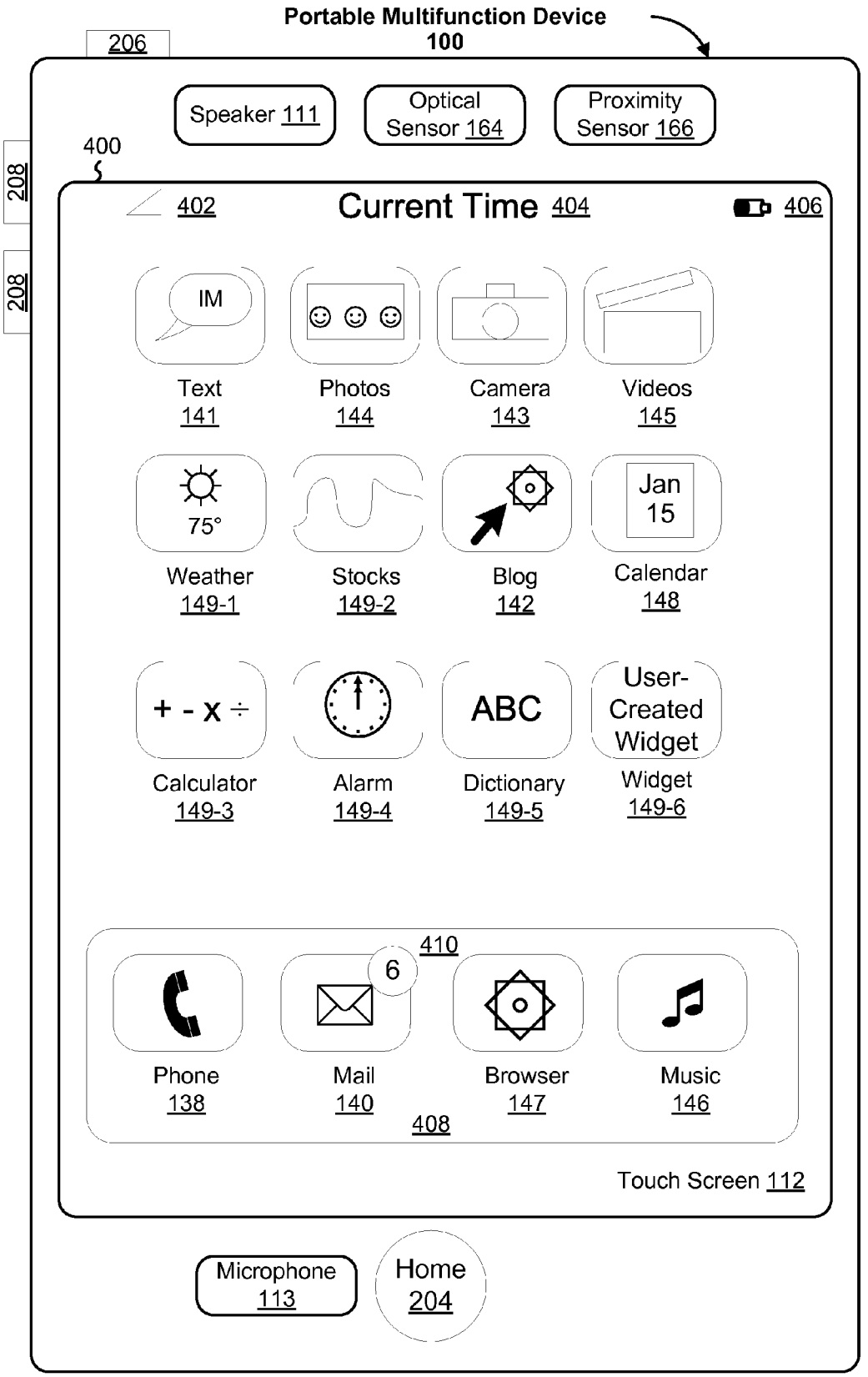

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
400
208
208
402
Current Time 404
406
IM
Text 141
Photos 144
Camera 143
Videos 145
75°
Weather 149-1
Stocks 149-2
Blog 142
Jan 15
Calendar 148
+ - x ÷
Calculator 149-3
Alarm 149-4
ABC
Dictionary 149-5
User-Created Widget
Widget 149-6
410
6
Phone 138
Mail 140
Browser 147
Music 146
408
Touch Screen 112
Microphone 113
Home 204

Figure 4

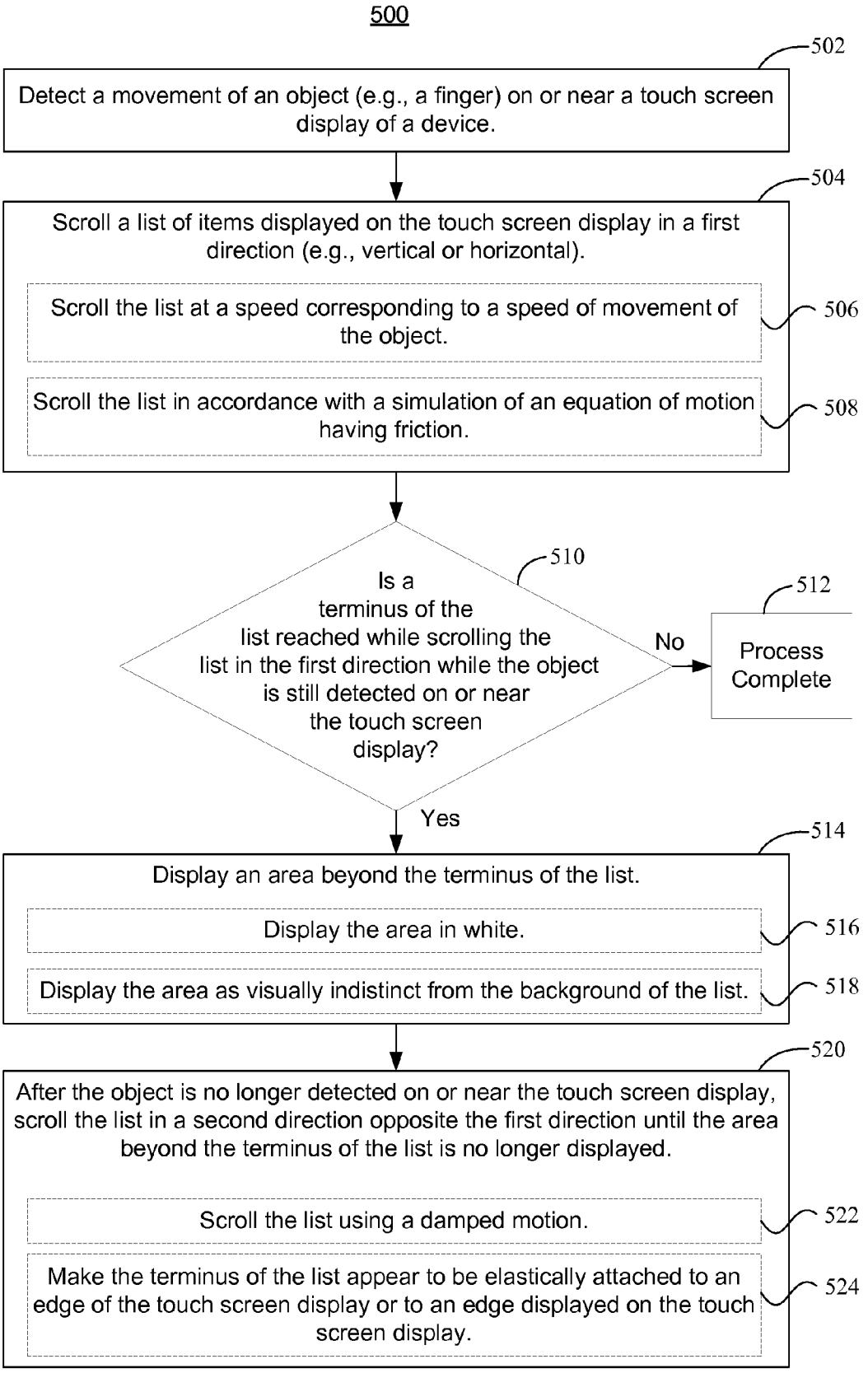

500
502
Detect a movement of an object (e.g., a finger) on or near a touch screen display of a device.
504
Scroll a list of items displayed on the touch screen display in a first direction (e.g., vertical or horizontal).
Scroll the list at a speed corresponding to a speed of movement of the object.
506
Scroll the list in accordance with a simulation of an equation of motion having friction.
508
510
Is a terminus of the list reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display?
No
512
Process Complete
Yes
514
Display an area beyond the terminus of the list.
Display the area in white.
516
Display the area as visually indistinct from the background of the list.
518
520
After the object is no longer detected on or near the touch screen display, scroll the list in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed.
Scroll the list using a damped motion.
522
Make the terminus of the list appear to be elastically attached to an edge of the touch screen display or to an edge displayed on the touch screen display.
524

Figure 5

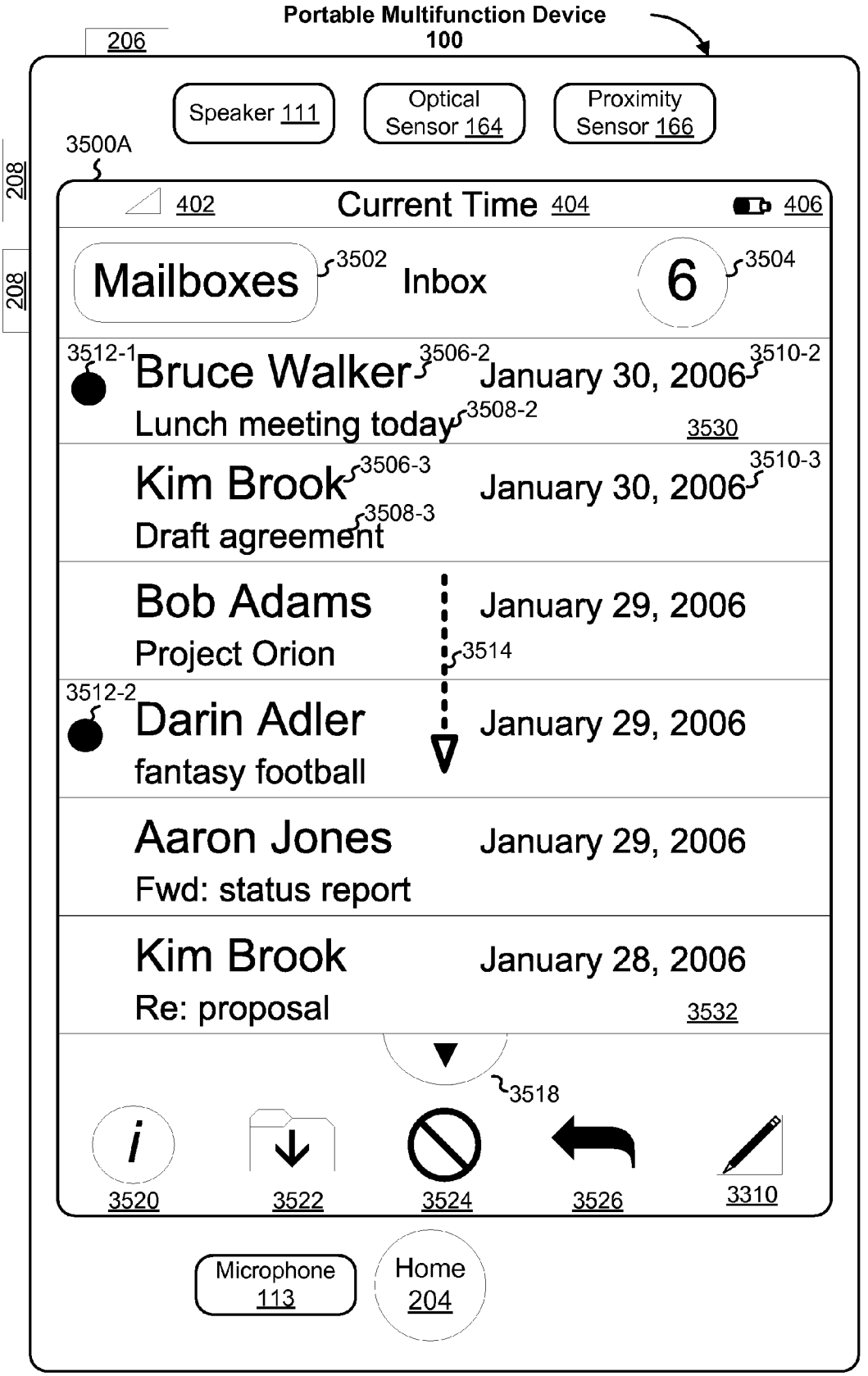

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3500A
208
208
402
Current Time 404
406
Mailboxes
3502
Inbox
6
3504
3512-1
Bruce Walker
3506-2
January 30, 2006
3510-2
Lunch meeting today
3508-2
3530
Kim Brook
3506-3
January 30, 2006
3510-3
Draft agreement
3508-3
Bob Adams
January 29, 2006
Project Orion
3514
3512-2
Darin Adler
January 29, 2006
fantasy football
Aaron Jones
January 29, 2006
Fwd: status report
Kim Brook
January 28, 2006
Re: proposal
3532
3518
3520
3522
3524
3526
3310
Microphone 113
Home 204

Figure 6A

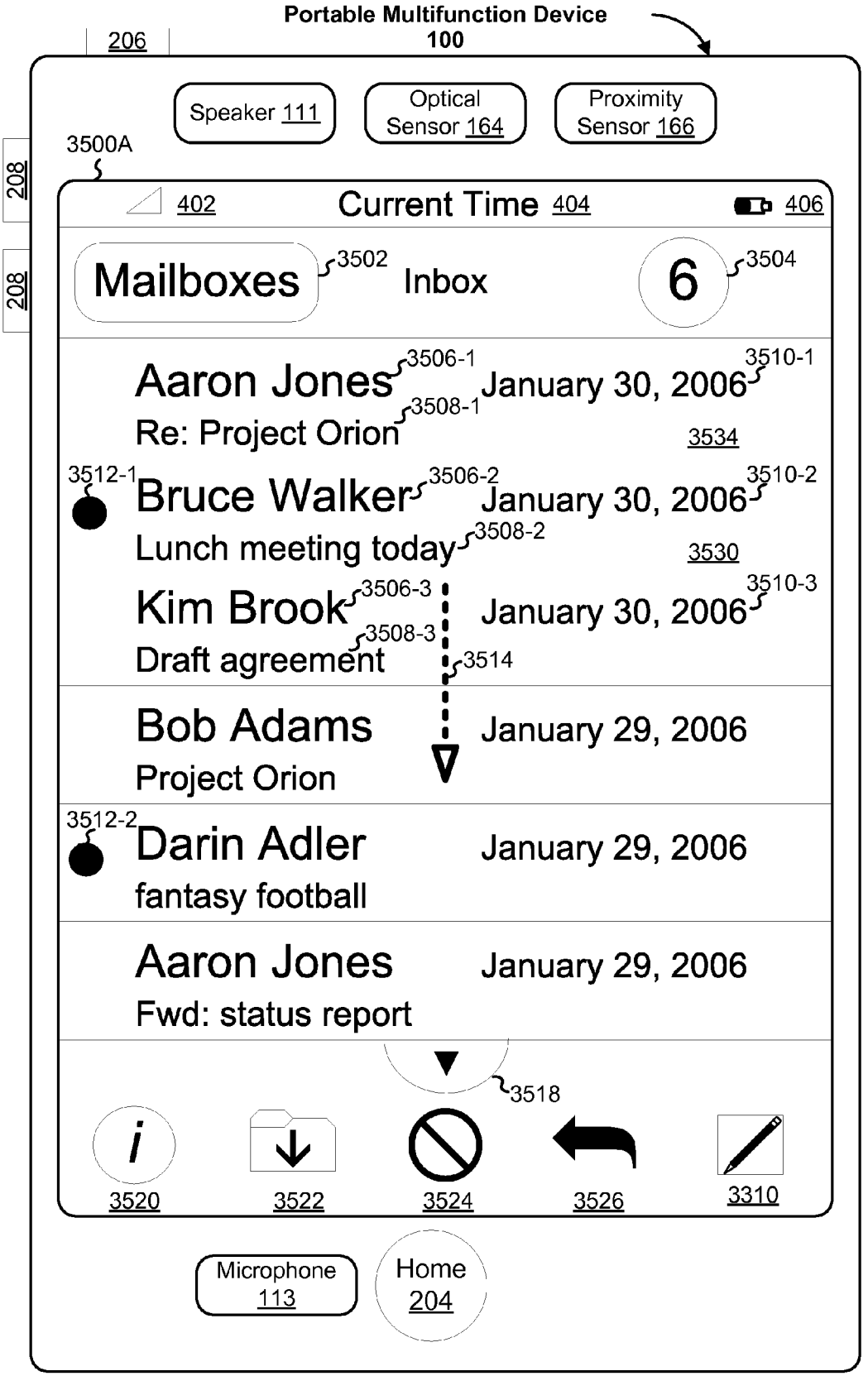

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3500A
208
208
402
Current Time 404
406
Mailboxes
3502
Inbox
6
3504
Aaron Jones
3506-1
January 30, 2006
3510-1
Re: Project Orion
3508-1
3534
3512-1
Bruce Walker
3506-2
January 30, 2006
3510-2
Lunch meeting today
3508-2
3530
Kim Brook
3506-3
January 30, 2006
3510-3
Draft agreement
3508-3
3514
Bob Adams
January 29, 2006
Project Orion
3512-2
Darin Adler
January 29, 2006
fantasy football
Aaron Jones
January 29, 2006
Fwd: status report
3518
3520
3522
3524
3526
3310
Microphone 113
Home 204

Figure 6B

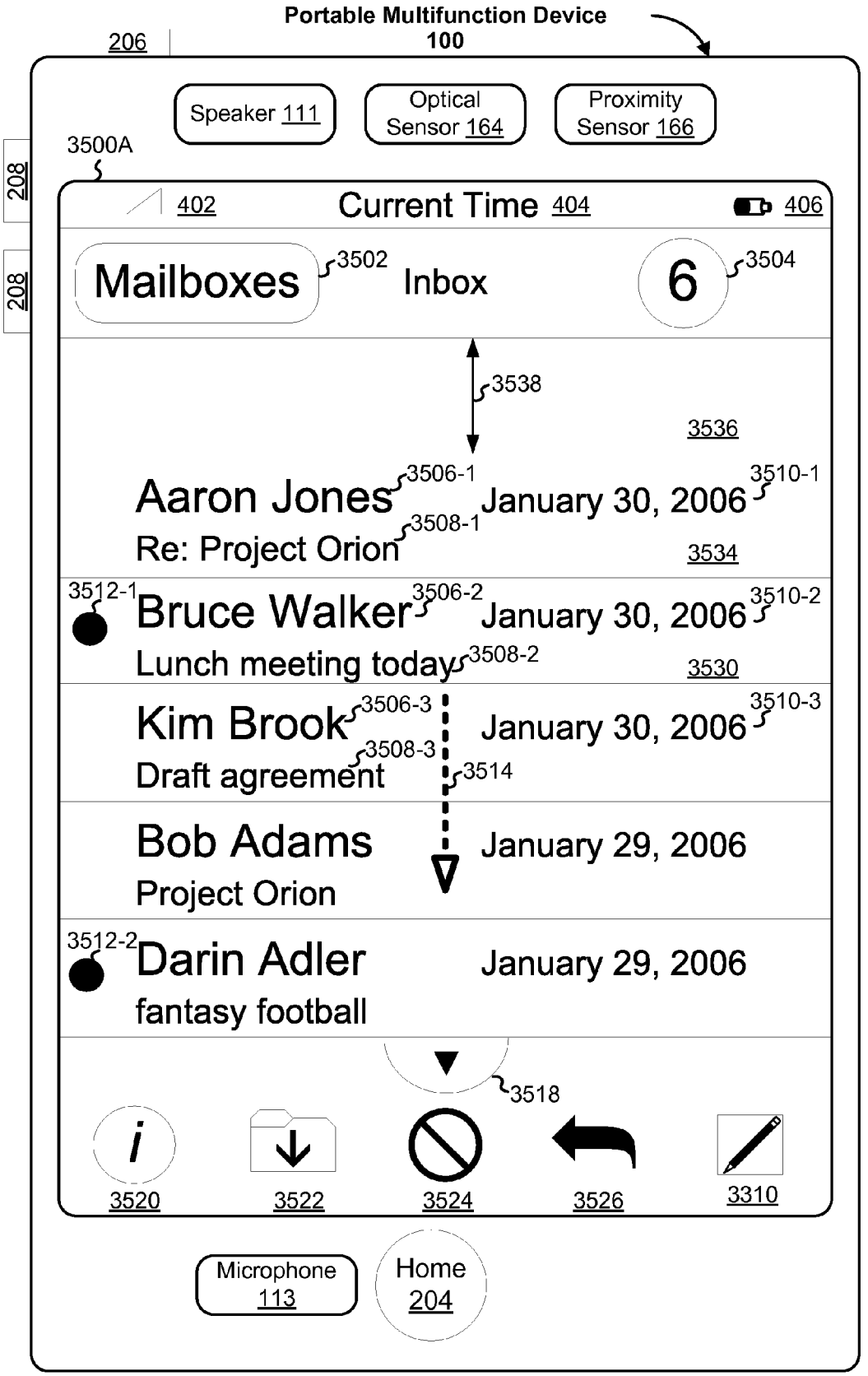

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3500A
208
208
402
Current Time 404
406
Mailboxes
3502
Inbox
6
3504
3538
3536
3506-1
Aaron Jones
3510-1
January 30, 2006
3508-1
Re: Project Orion
3534
3512-1
3506-2
Bruce Walker
3510-2
January 30, 2006
3508-2
Lunch meeting today
3530
3506-3
Kim Brook
3510-3
January 30, 2006
3508-3
Draft agreement
3514
Bob Adams
January 29, 2006
Project Orion
3512-2
Darin Adler
January 29, 2006
fantasy football
3518
3520
3522
3524
3526
3310
Microphone 113
Home 204

Figure 6C

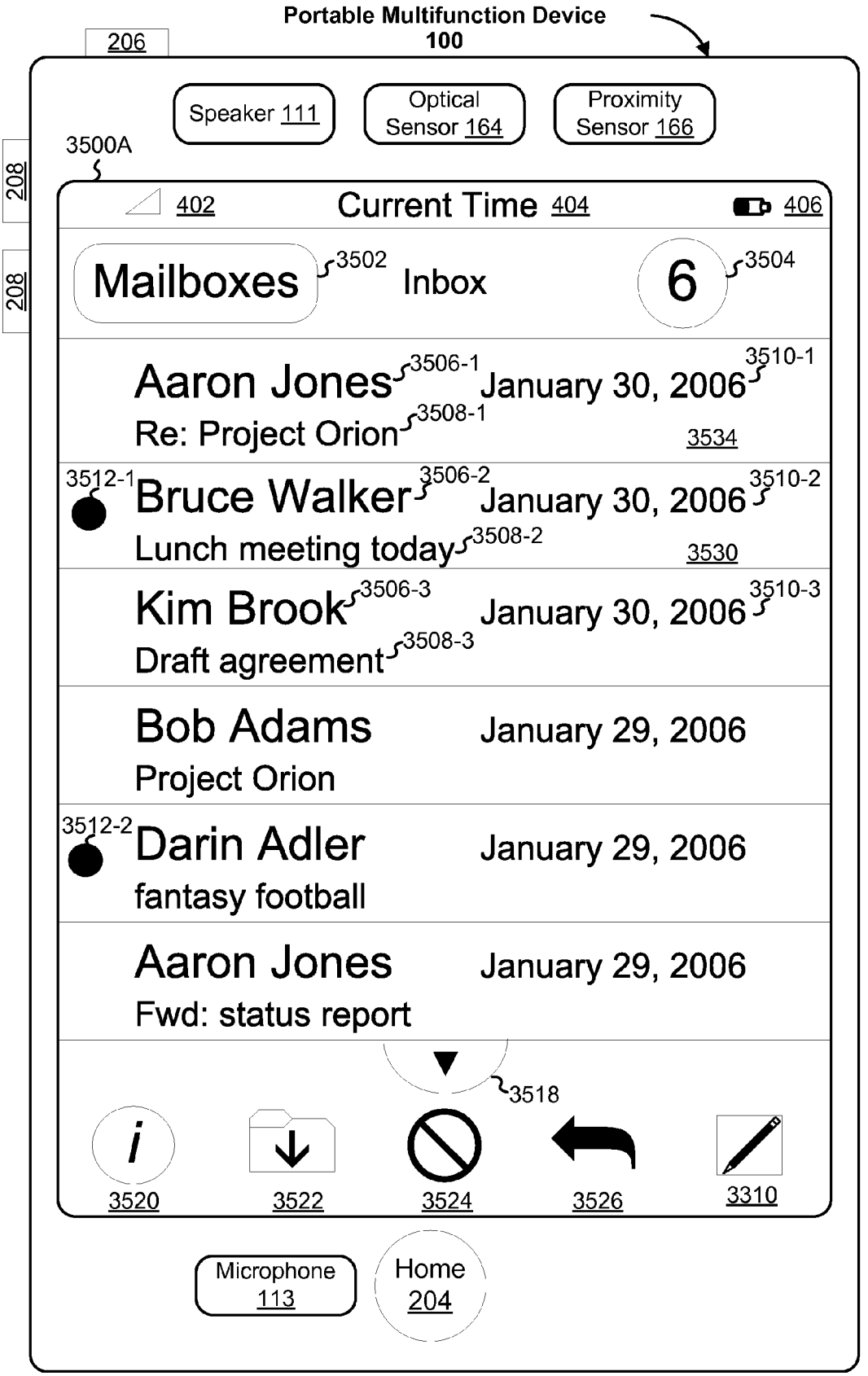

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3500A
208
208
402
Current Time 404
406
Mailboxes
3502
Inbox
6
3504
Aaron Jones
3506-1
January 30, 2006
3510-1
Re: Project Orion
3508-1
3534
3512-1
Bruce Walker
3506-2
January 30, 2006
3510-2
Lunch meeting today
3508-2
3530
Kim Brook
3506-3
January 30, 2006
3510-3
Draft agreement
3508-3
Bob Adams
January 29, 2006
Project Orion
3512-2
Darin Adler
January 29, 2006
fantasy football
Aaron Jones
January 29, 2006
Fwd: status report
3518
3520
3522
3524
3526
3310
Microphone 113
Home 204

Figure 6D

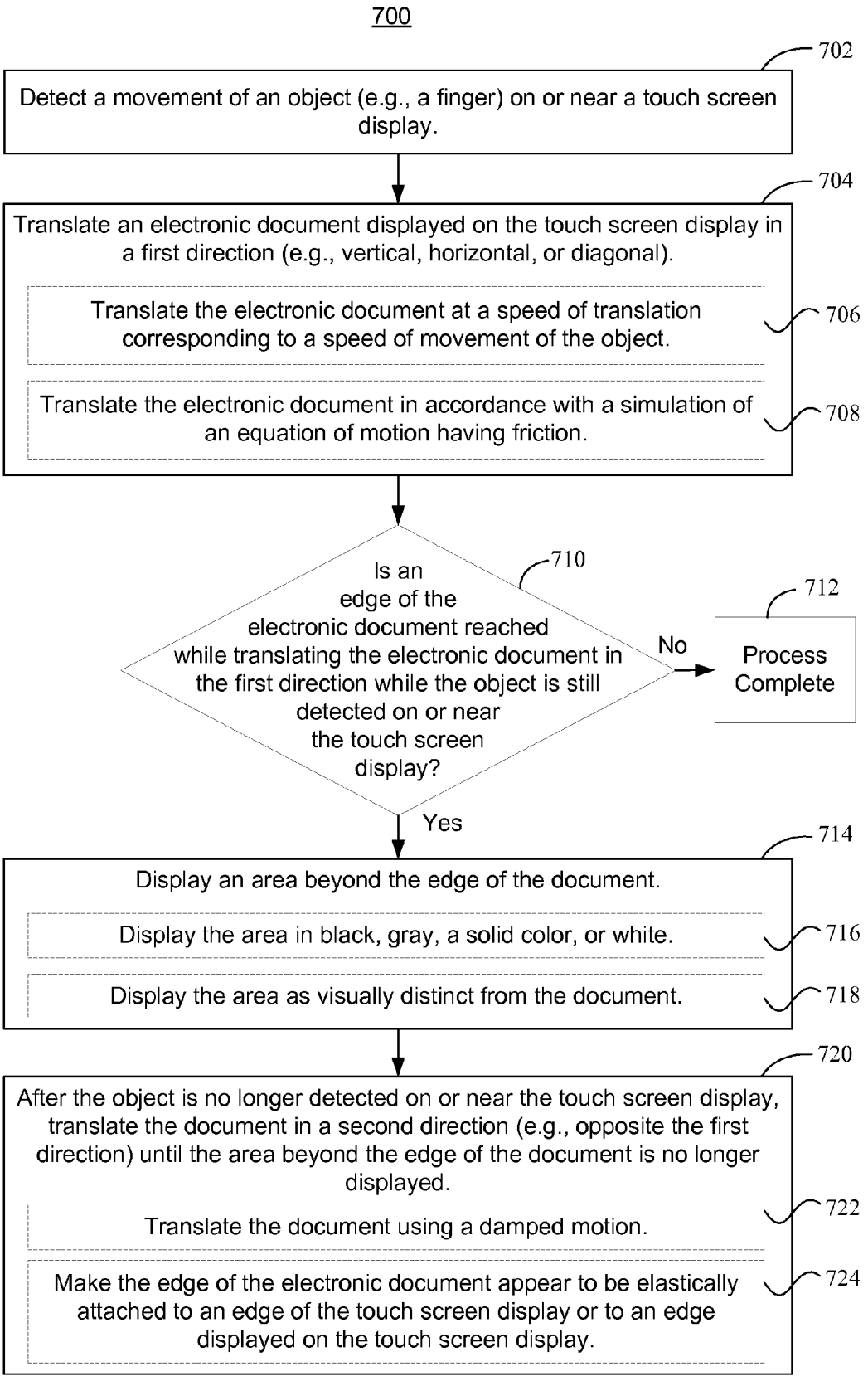

700
702
Detect a movement of an object (e.g., a finger) on or near a touch screen display.
704
Translate an electronic document displayed on the touch screen display in a first direction (e.g., vertical, horizontal, or diagonal).
Translate the electronic document at a speed of translation corresponding to a speed of movement of the object.
706
Translate the electronic document in accordance with a simulation of an equation of motion having friction.
708
Is an edge of the electronic document reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display?
710
No
712
Process Complete
Yes
714
Display an area beyond the edge of the document.
Display the area in black, gray, a solid color, or white.
716
Display the area as visually distinct from the document.
718
720
After the object is no longer detected on or near the touch screen display, translate the document in a second direction (e.g., opposite the first direction) until the area beyond the edge of the document is no longer displayed.
Translate the document using a damped motion.
722
Make the edge of the electronic document appear to be elastically attached to an edge of the touch screen display or to an edge displayed on the touch screen display.
724

Figure 7

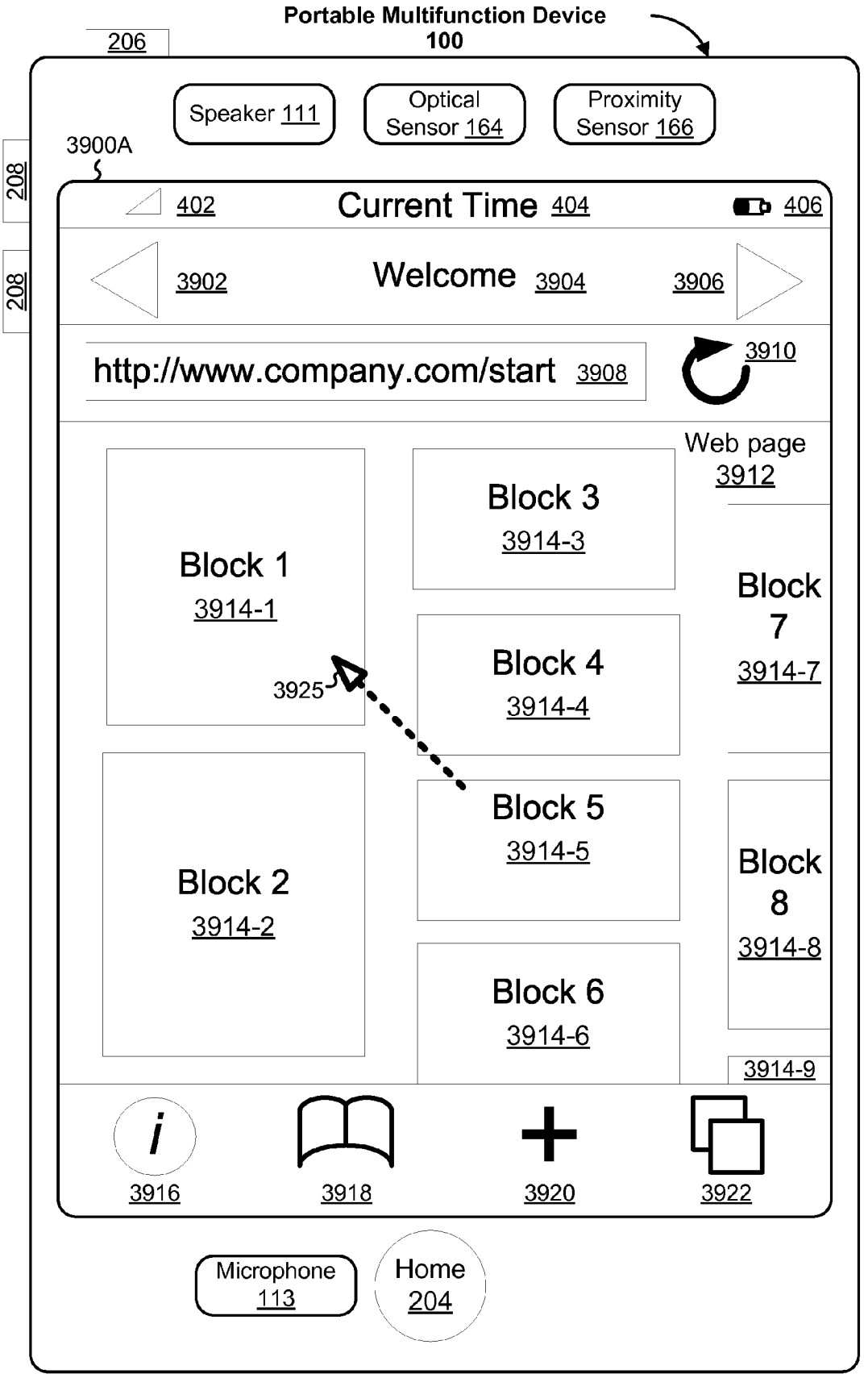

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Web page
3912
Block 1
3914-1
Block 3
3914-3
Block 4
3914-4
Block 5
3914-5
Block 6
3914-6
Block 2
3914-2
Block 7
3914-7
Block 8
3914-8
3914-9
3925
3916
3918
3920
3922
Microphone 113
Home 204

Figure 8A

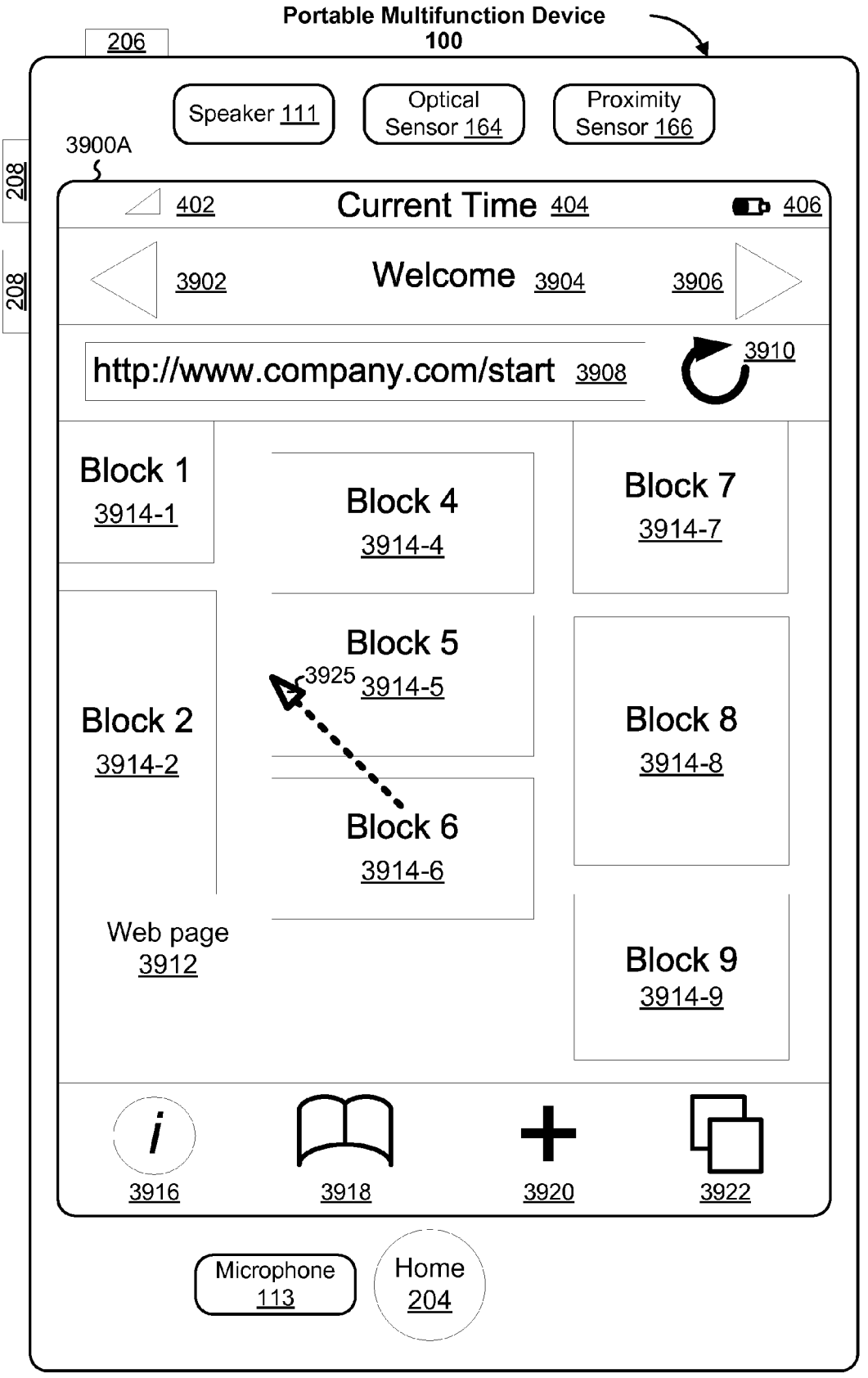

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Block 1
3914-1
Block 4
3914-4
Block 7
3914-7
Block 5
3914-5
3925
Block 2
3914-2
Block 8
3914-8
Block 6
3914-6
Web page
3912
Block 9
3914-9
3916
3918
3920
3922
Microphone
113
Home
204

Figure 8B

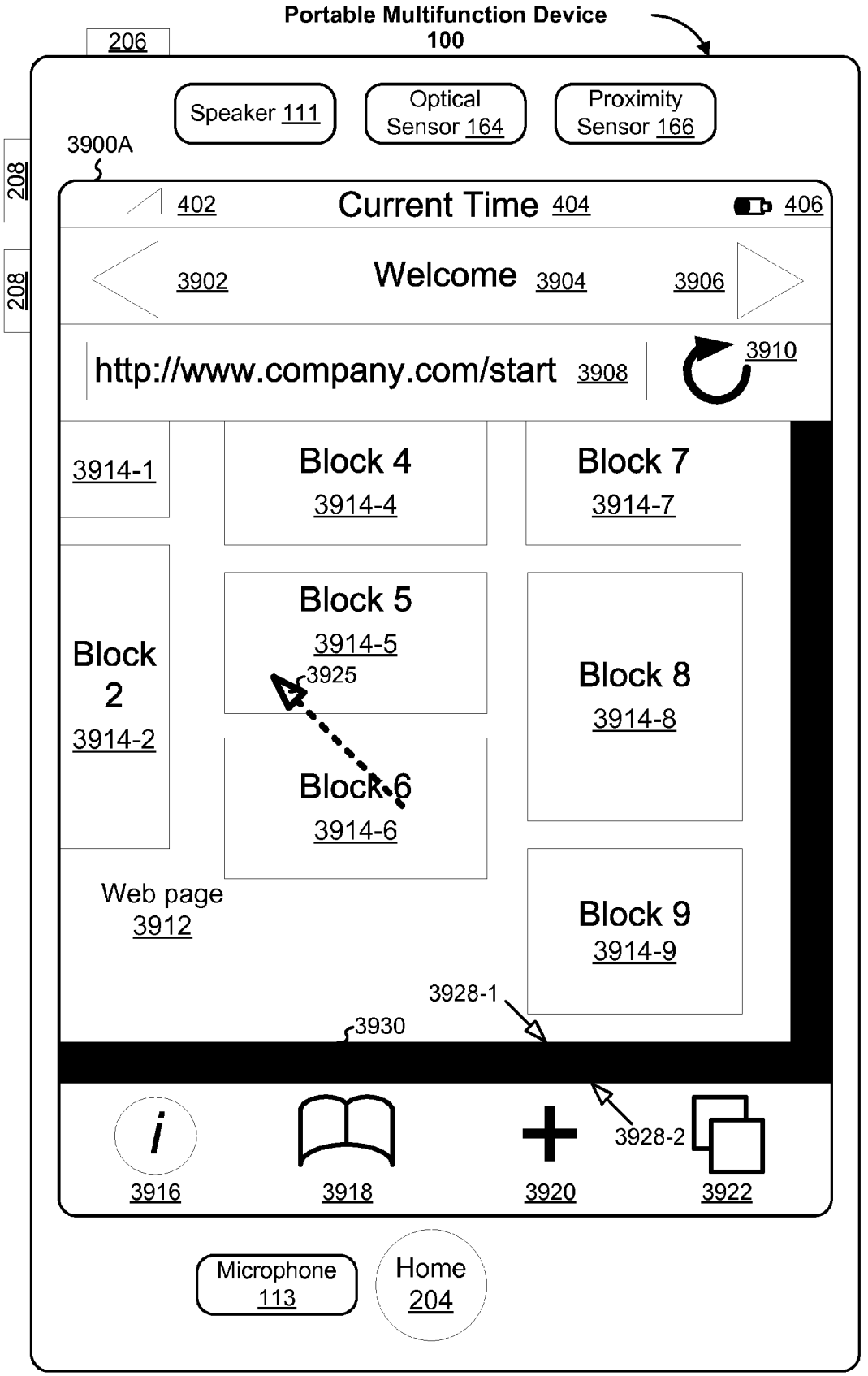

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
3914-1
Block 4
3914-4
Block 7
3914-7
Block 5
3914-5
3925
Block 8
3914-8
Block 2
3914-2
Block 6
3914-6
Web page
3912
Block 9
3914-9
3928-1
3930
3928-2
3916
3918
3920
3922
Microphone
113
Home
204

Figure 8C

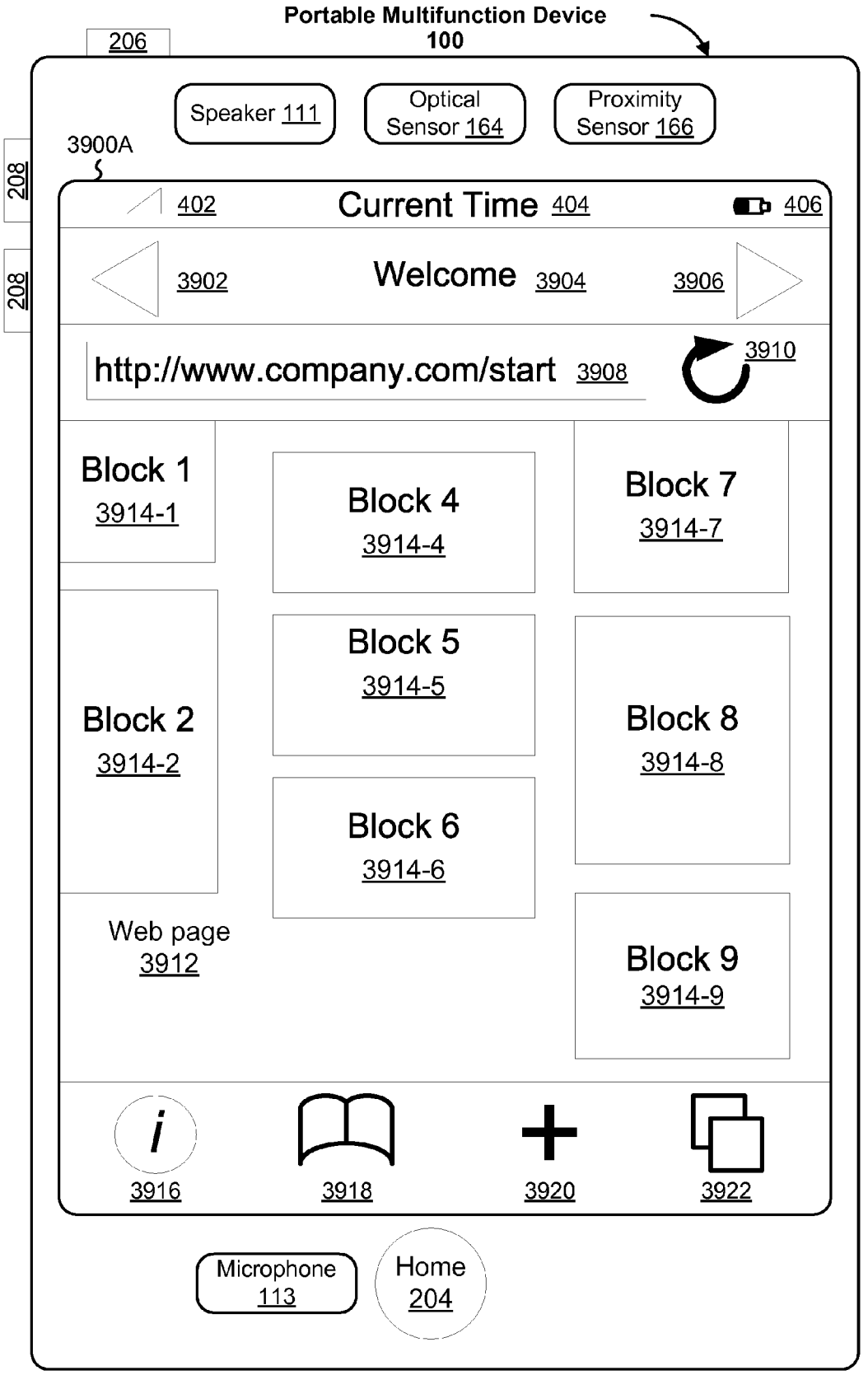

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Block 1
3914-1
Block 4
3914-4
Block 7
3914-7
Block 2
3914-2
Block 5
3914-5
Block 8
3914-8
Block 6
3914-6
Web page
3912
Block 9
3914-9
3916
3918
3920
3922
Microphone
113
Home
204

Figure 8D

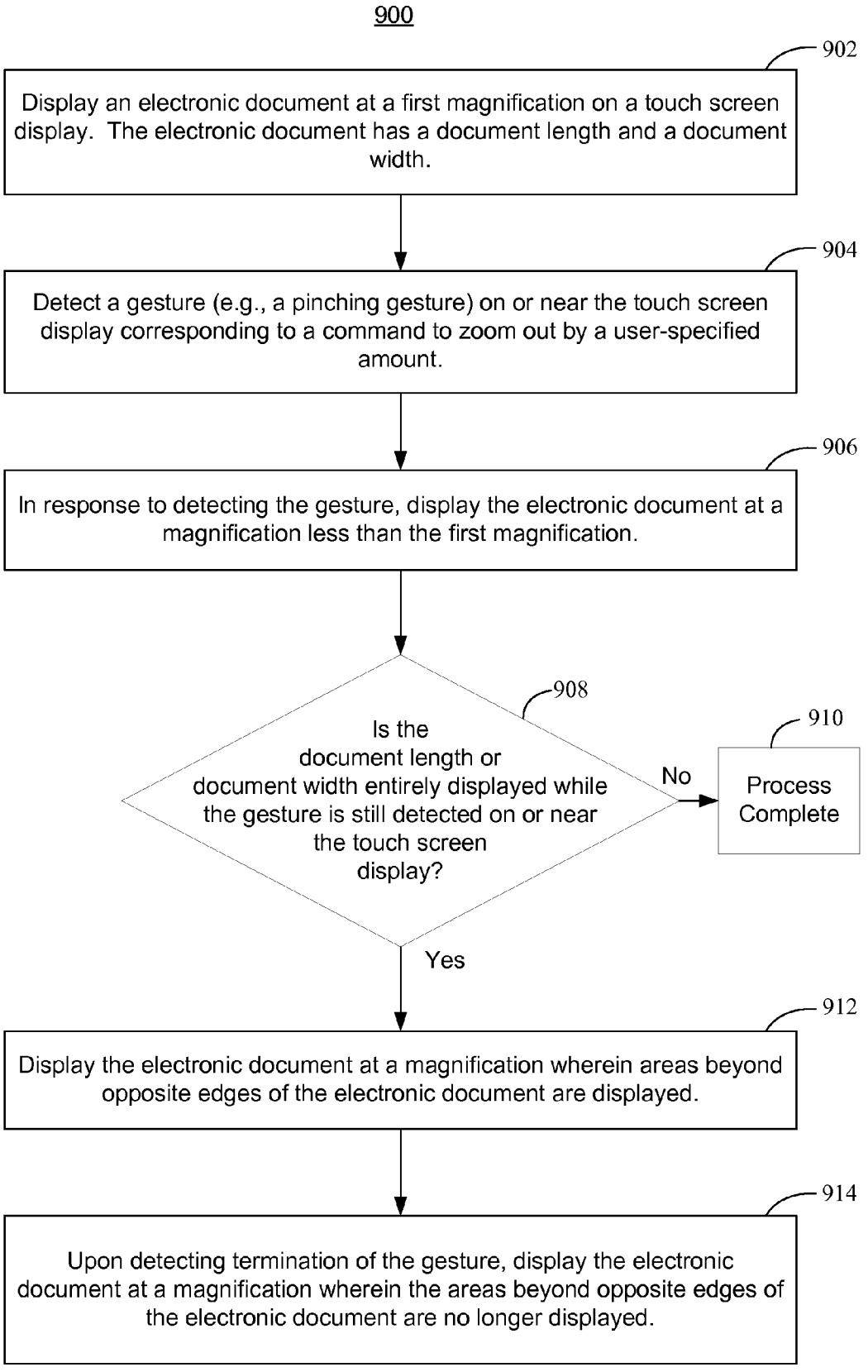

900
902
Display an electronic document at a first magnification on a touch screen display. The electronic document has a document length and a document width.
904
Detect a gesture (e.g., a pinching gesture) on or near the touch screen display corresponding to a command to zoom out by a user-specified amount.
906
In response to detecting the gesture, display the electronic document at a magnification less than the first magnification.
908
Is the document length or document width entirely displayed while the gesture is still detected on or near the touch screen display?
No
910
Process Complete
Yes
912
Display the electronic document at a magnification wherein areas beyond opposite edges of the electronic document are displayed.
914
Upon detecting termination of the gesture, display the electronic document at a magnification wherein the areas beyond opposite edges of the electronic document are no longer displayed.

Figure 9

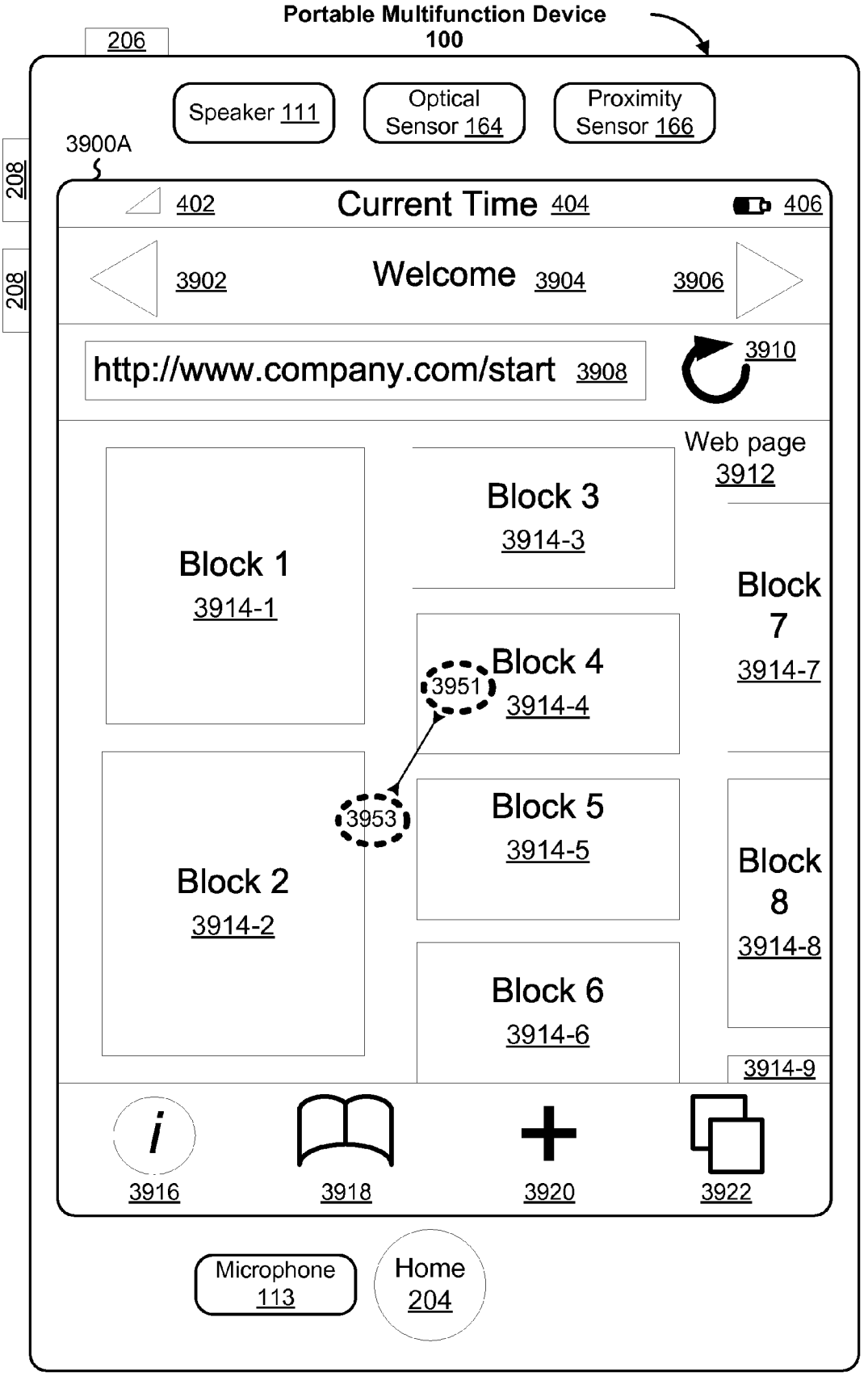

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Web page
3912
Block 1
3914-1
Block 3
3914-3
Block 4
3914-4
3951
Block 7
3914-7
3953
Block 2
3914-2
Block 5
3914-5
Block 8
3914-8
Block 6
3914-6
3914-9
3916
3918
3920
3922
Microphone
113
Home
204

Figure 10A

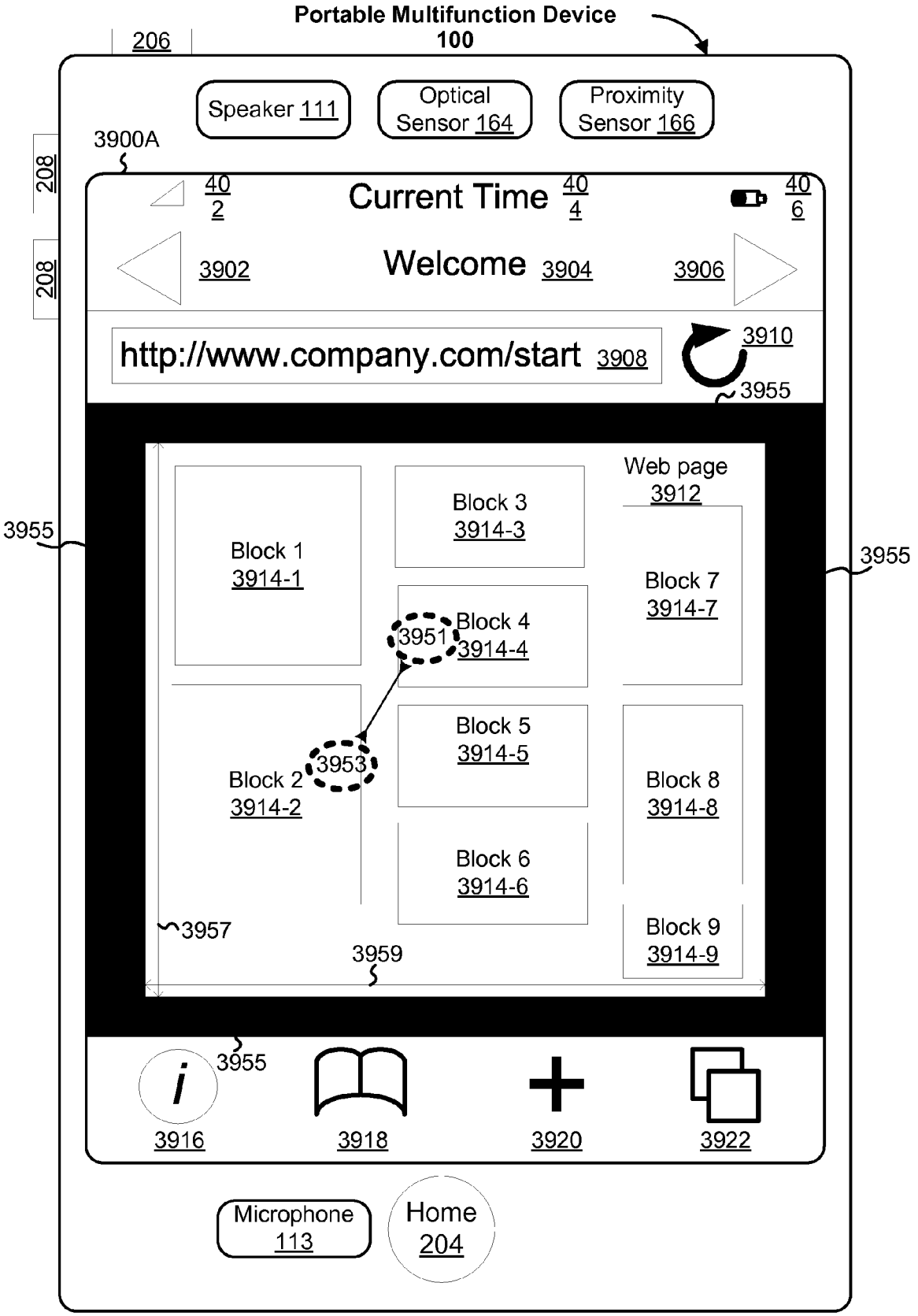

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
40
2
Current Time
40
4
40
6
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
3955
Web page
3912
Block 1
3914-1
Block 3
3914-3
Block 7
3914-7
Block 4
3914-4
3951
Block 5
3914-5
Block 2
3914-2
3953
Block 8
3914-8
Block 6
3914-6
Block 9
3914-9
3957
3959
3955
3955
3955
3916
3918
3920
3922
Microphone
113
Home
204

Figure 10B

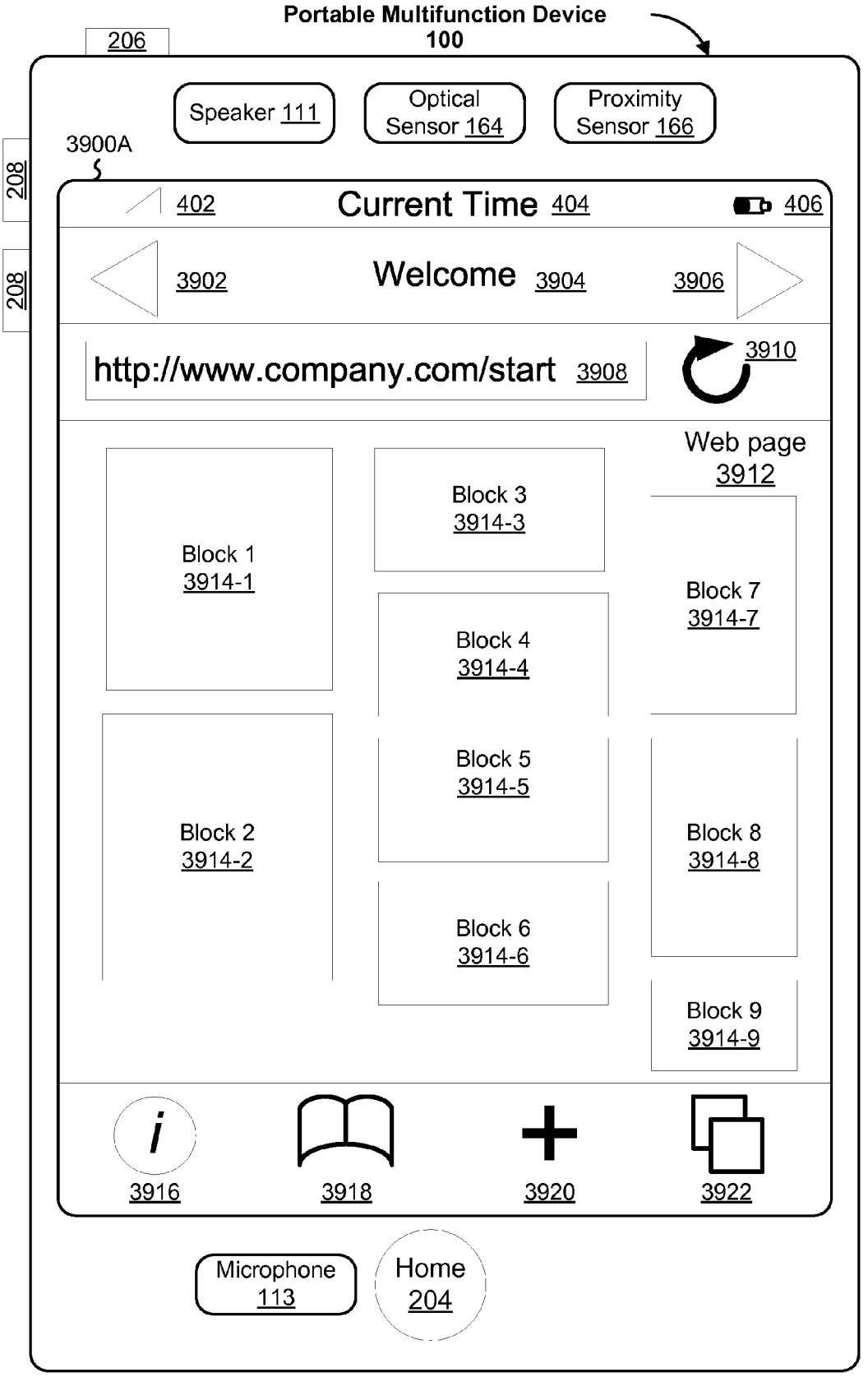

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Web page
3912
Block 1
3914-1
Block 2
3914-2
Block 3
3914-3
Block 4
3914-4
Block 5
3914-5
Block 6
3914-6
Block 7
3914-7
Block 8
3914-8
Block 9
3914-9
3916
3918
3920
3922
Microphone
113
Home
204

Figure 10C

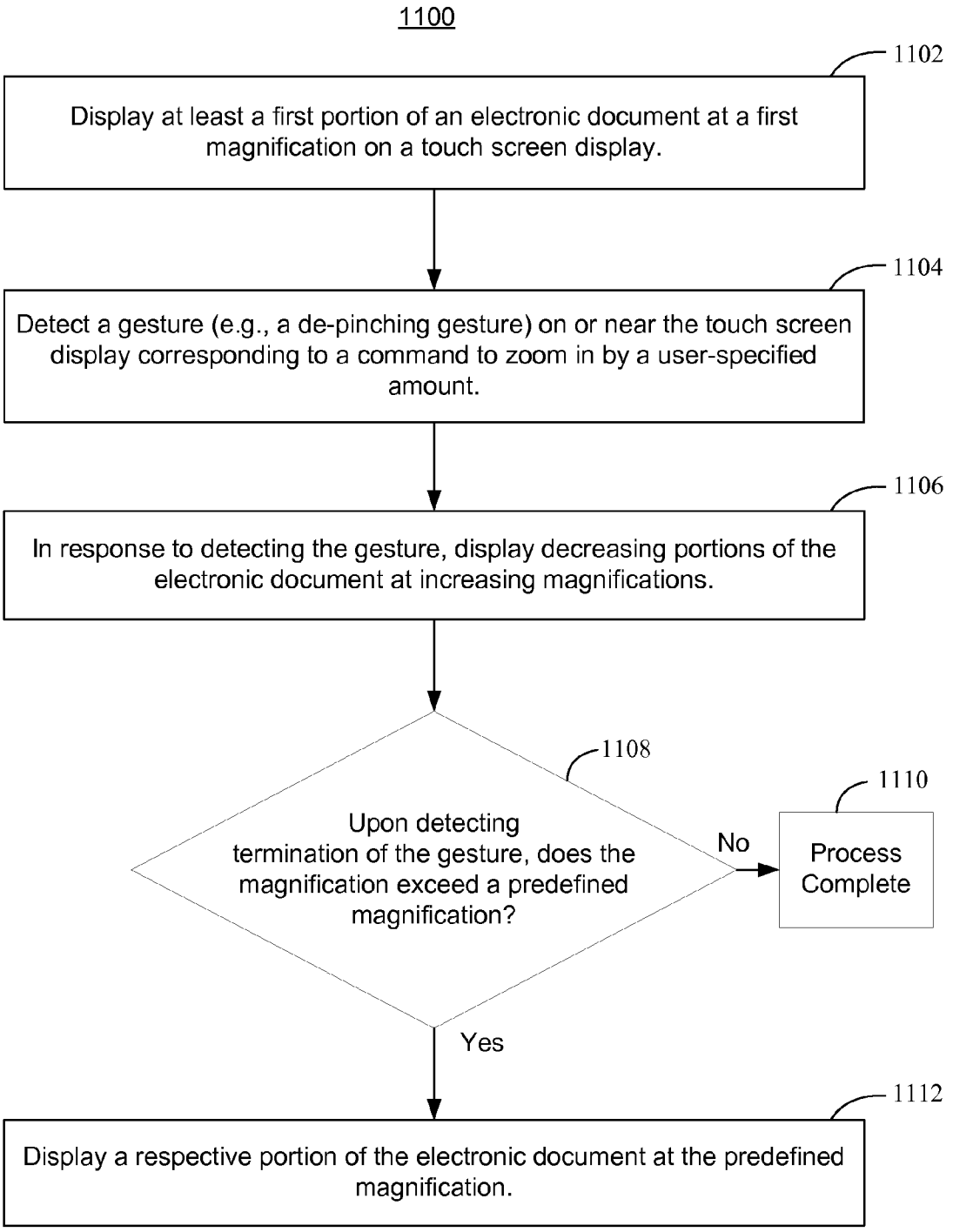

1100
1102
Display at least a first portion of an electronic document at a first magnification on a touch screen display.
1104
Detect a gesture (e.g., a de-pinching gesture) on or near the touch screen display corresponding to a command to zoom in by a user-specified amount.
1106
In response to detecting the gesture, display decreasing portions of the electronic document at increasing magnifications.
1108
Upon detecting termination of the gesture, does the magnification exceed a predefined magnification?
No
1110
Process Complete
Yes
1112
Display a respective portion of the electronic document at the predefined magnification.

Figure 11

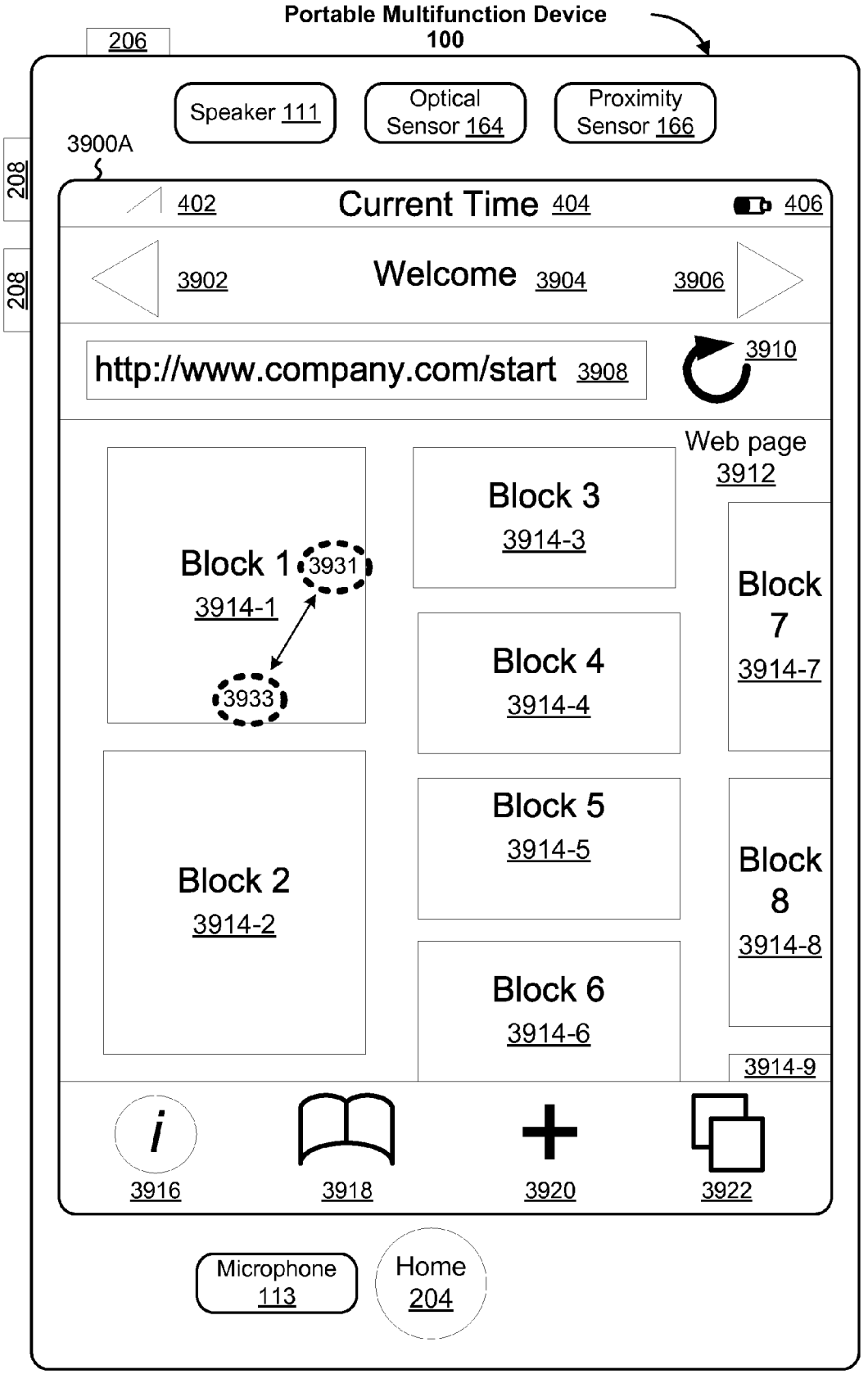

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Web page
3912
Block 1
3914-1
3931
3933
Block 3
3914-3
Block 4
3914-4
Block 5
3914-5
Block 6
3914-6
Block 7
3914-7
Block 8
3914-8
Block 2
3914-2
3914-9
i
3916
3918
3920
3922
Microphone
113
Home
204

Figure 12A

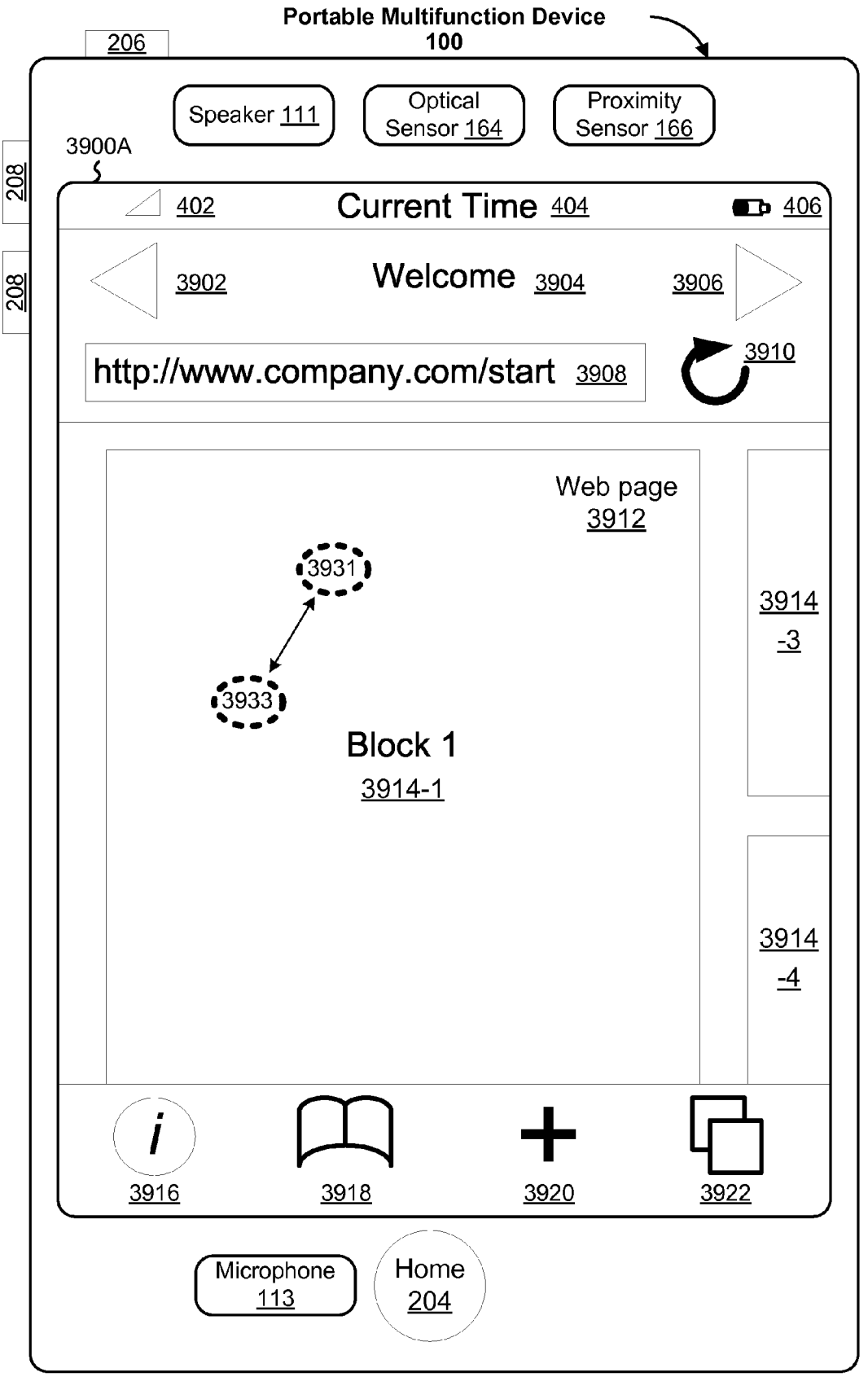

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Web page
3912
3931
3933
Block 1
3914-1
3914
-3
3914
-4
3916
3918
3920
3922
Microphone 113
Home 204

Figure 12B

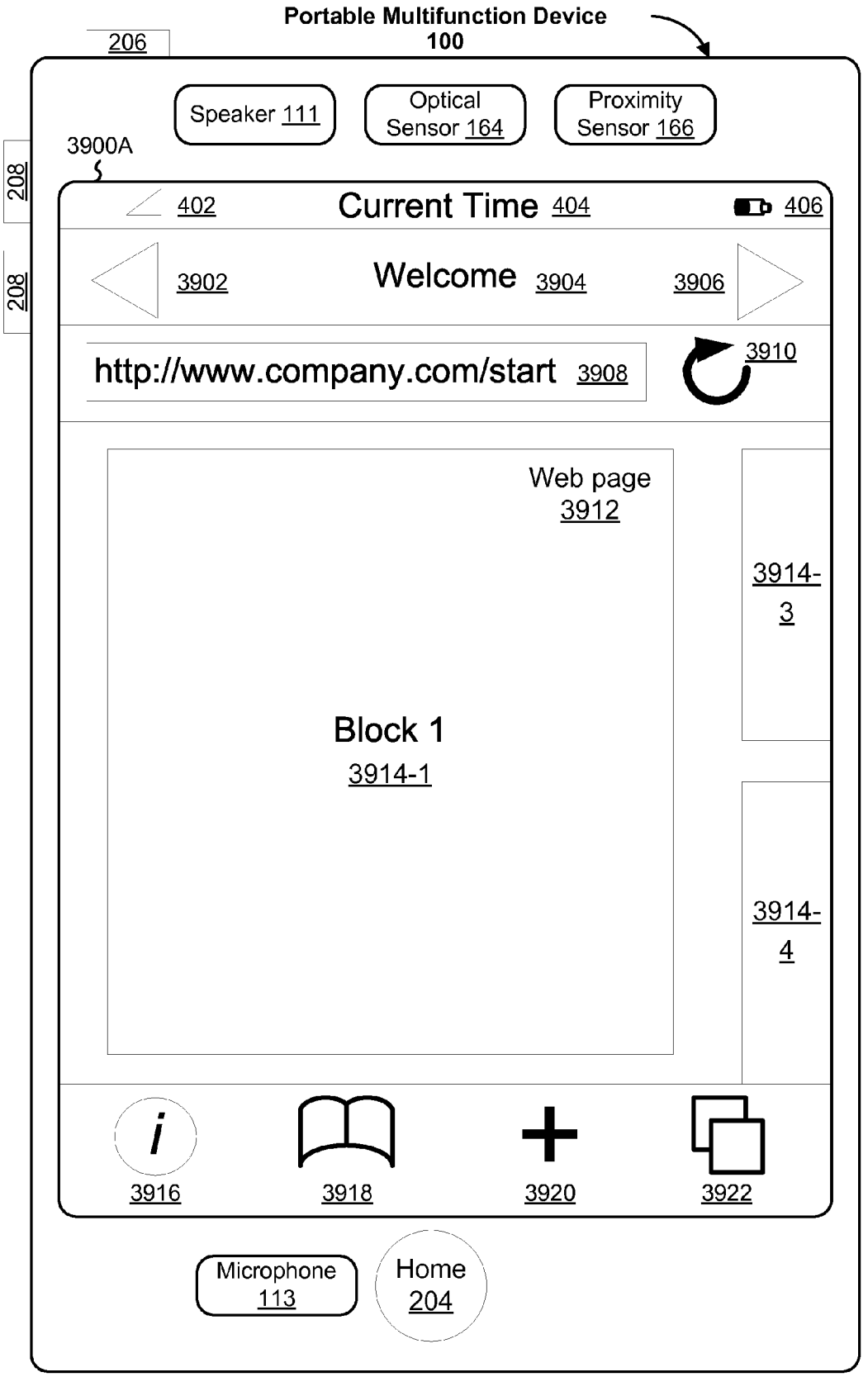

Portable Multifunction Device
100
206
Speaker 111
Optical Sensor 164
Proximity Sensor 166
3900A
208
208
402
Current Time 404
406
3902
Welcome 3904
3906
http://www.company.com/start 3908
3910
Web page
3912
3914-3
Block 1
3914-1
3914-4
3916
3918
3920
3922
Microphone 113
Home 204

Figure 12C

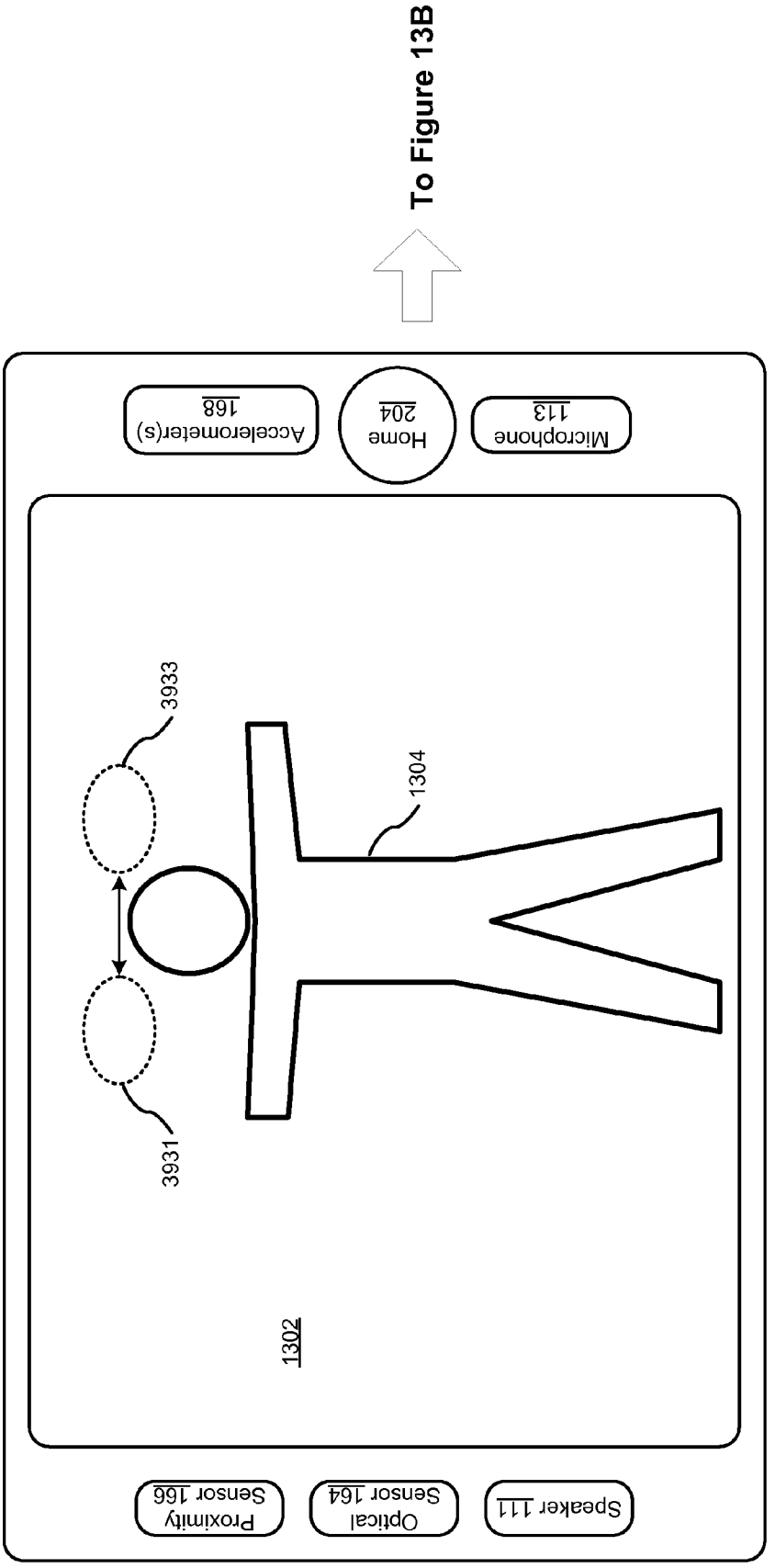

To Figure 13B
Microphone 113
Home 204
Accelerometer(s) 168
3933
1304
3931
1302
Speaker 111
Optical Sensor 164
Proximity Sensor 166

Figure 13A

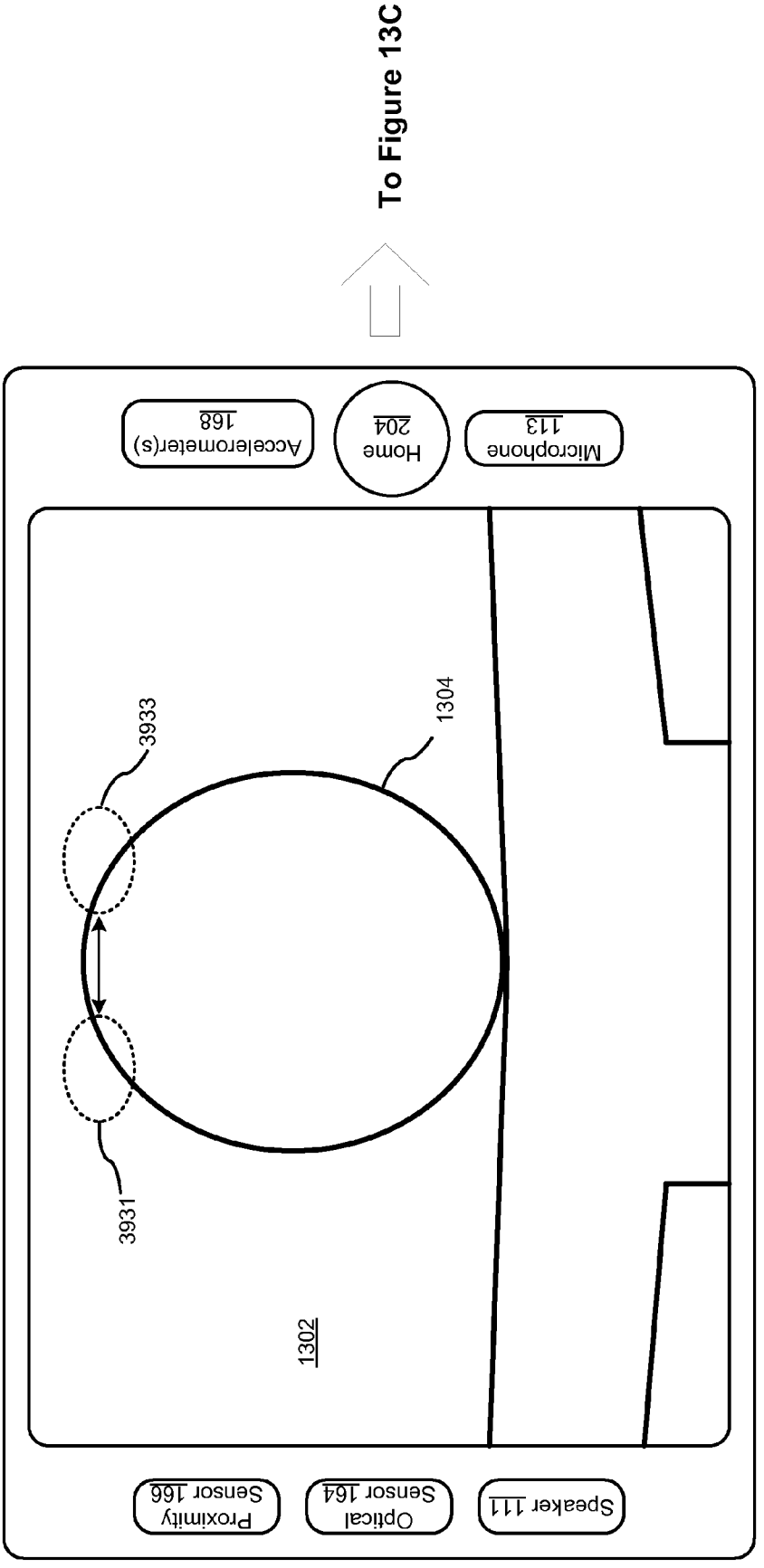

To Figure 13C
Accelerometer(s) 168
Home 204
Microphone 113
1304
3933
3931
1302
Proximity Sensor 166
Optical Sensor 164
Speaker 111

Figure 13B

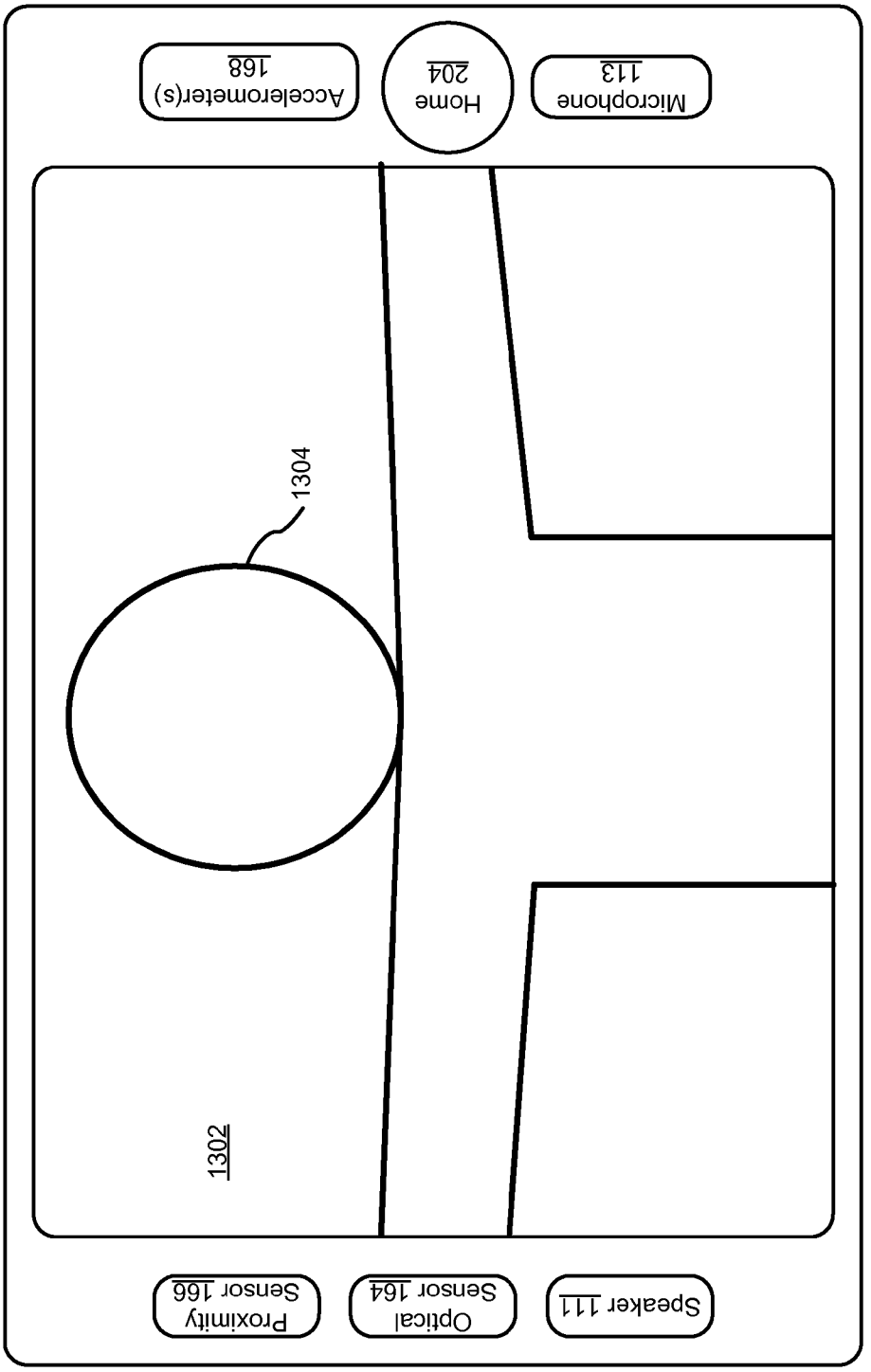

Accelerometer(s) 168
Home 204
Microphone 113
1304
1302
Proximity Sensor 166
Optical Sensor 164
Speaker 111

Figure 13C

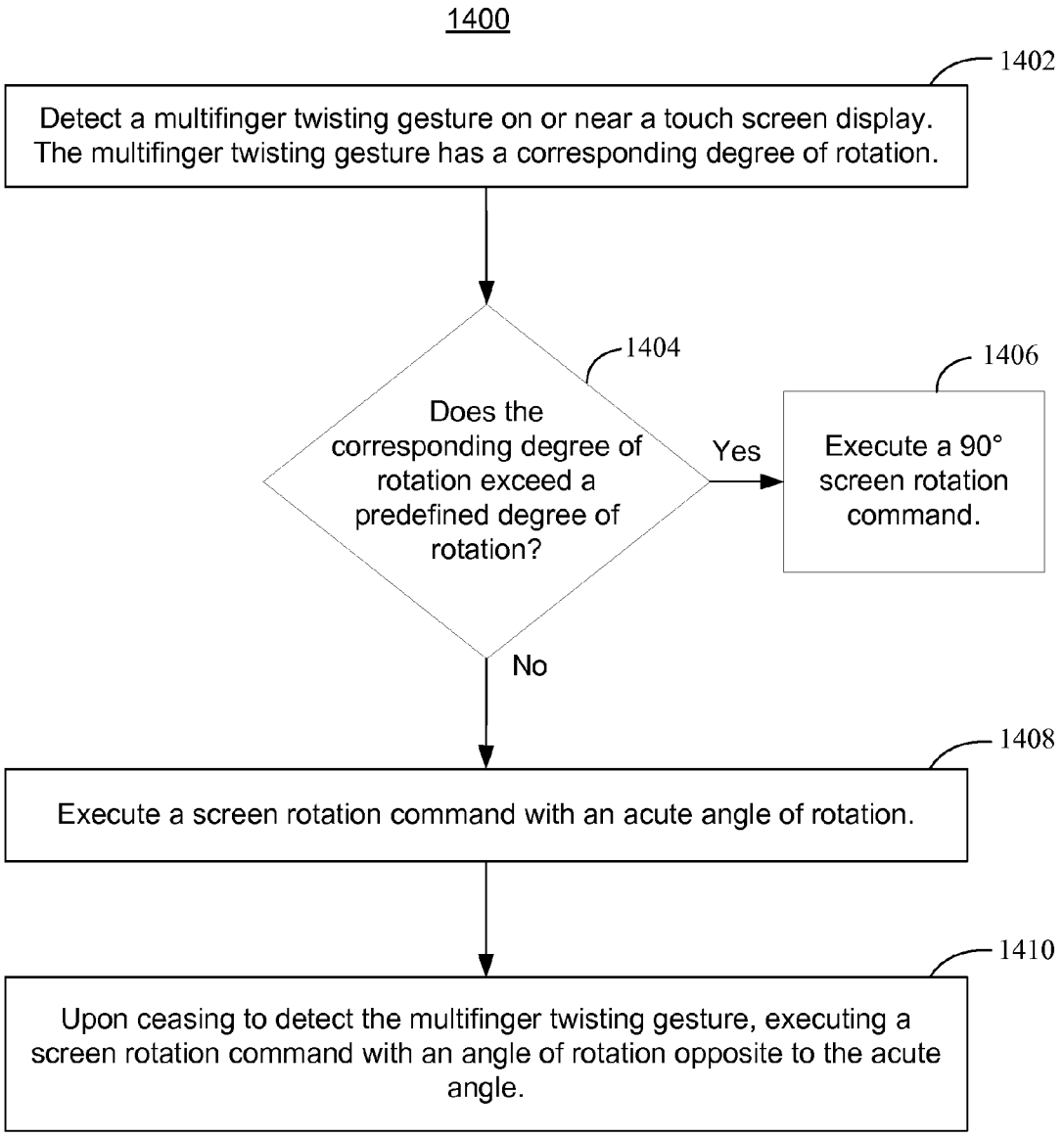
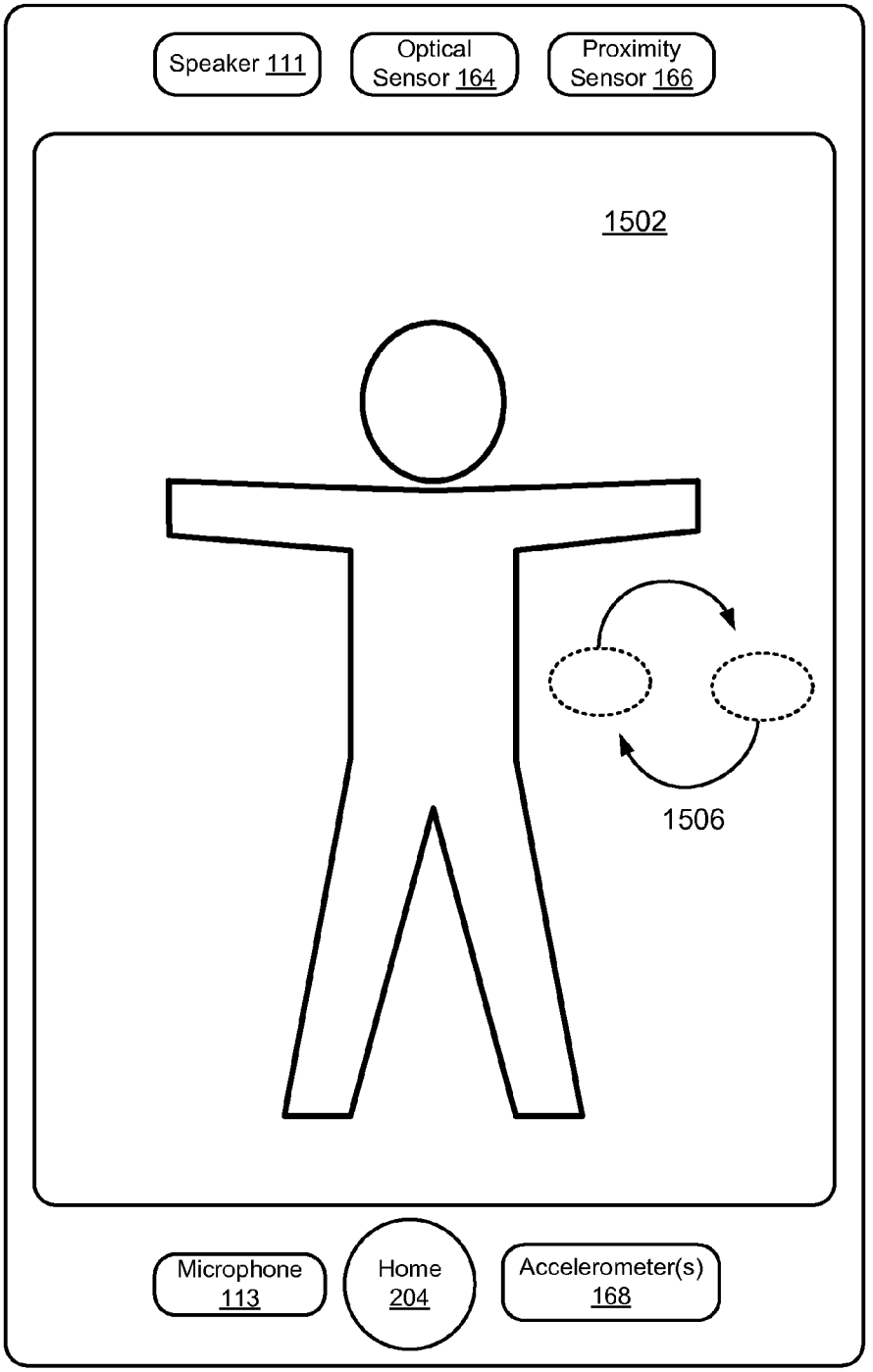

1400
1402
Detect a multifinger twisting gesture on or near a touch screen display. The multifinger twisting gesture has a corresponding degree of rotation.
1404
Does the corresponding degree of rotation exceed a predefined degree of rotation?
Yes
1406
Execute a 90° screen rotation command.
No
1408
Execute a screen rotation command with an acute angle of rotation.
1410
Upon ceasing to detect the multifinger twisting gesture, executing a screen rotation command with an angle of rotation opposite to the acute angle.

Figure 14



To Figure 15B

Figure 15A

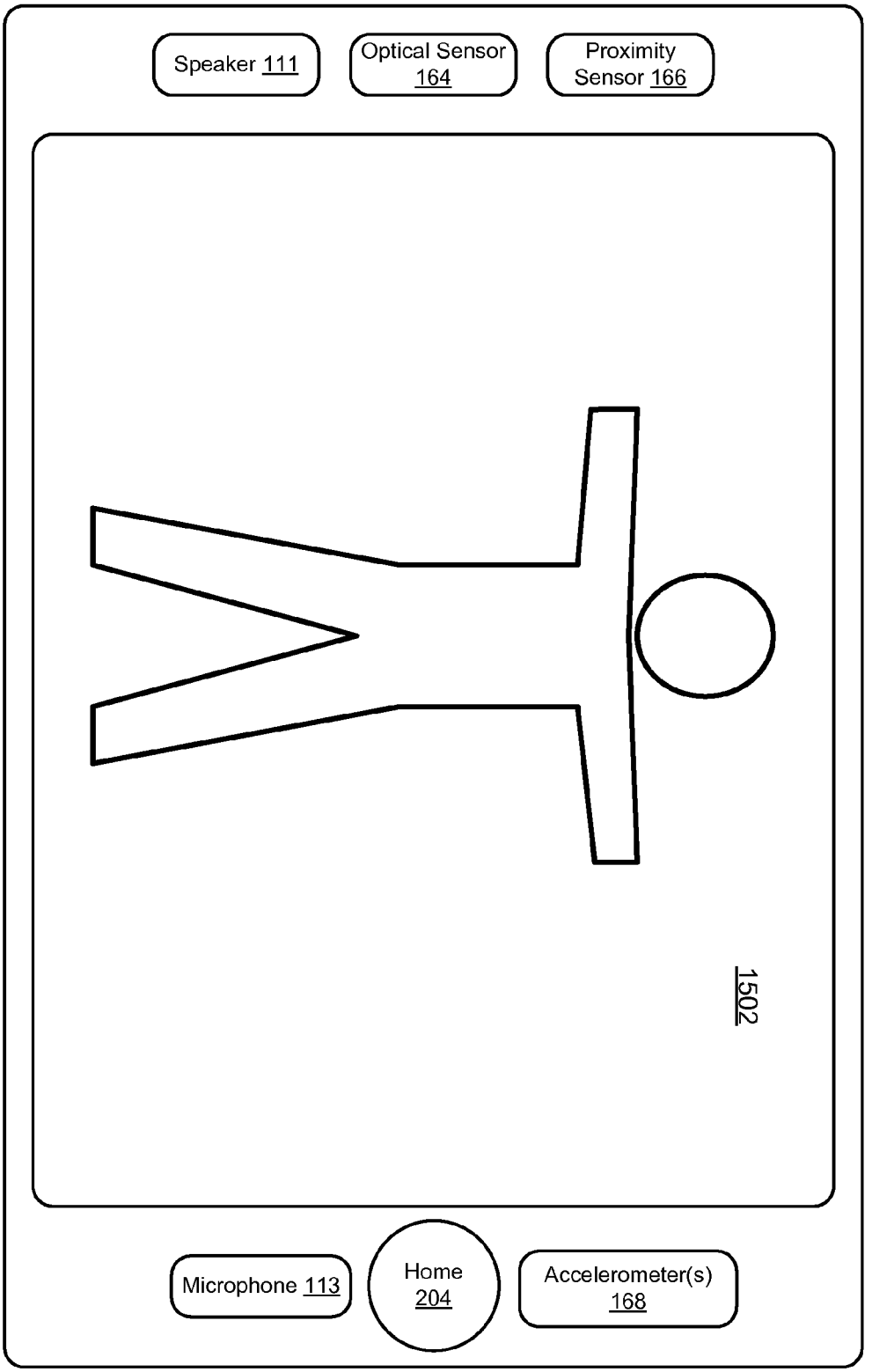

Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
Microphone 113
Home 204
Accelerometer(s) 168

Figure 15B

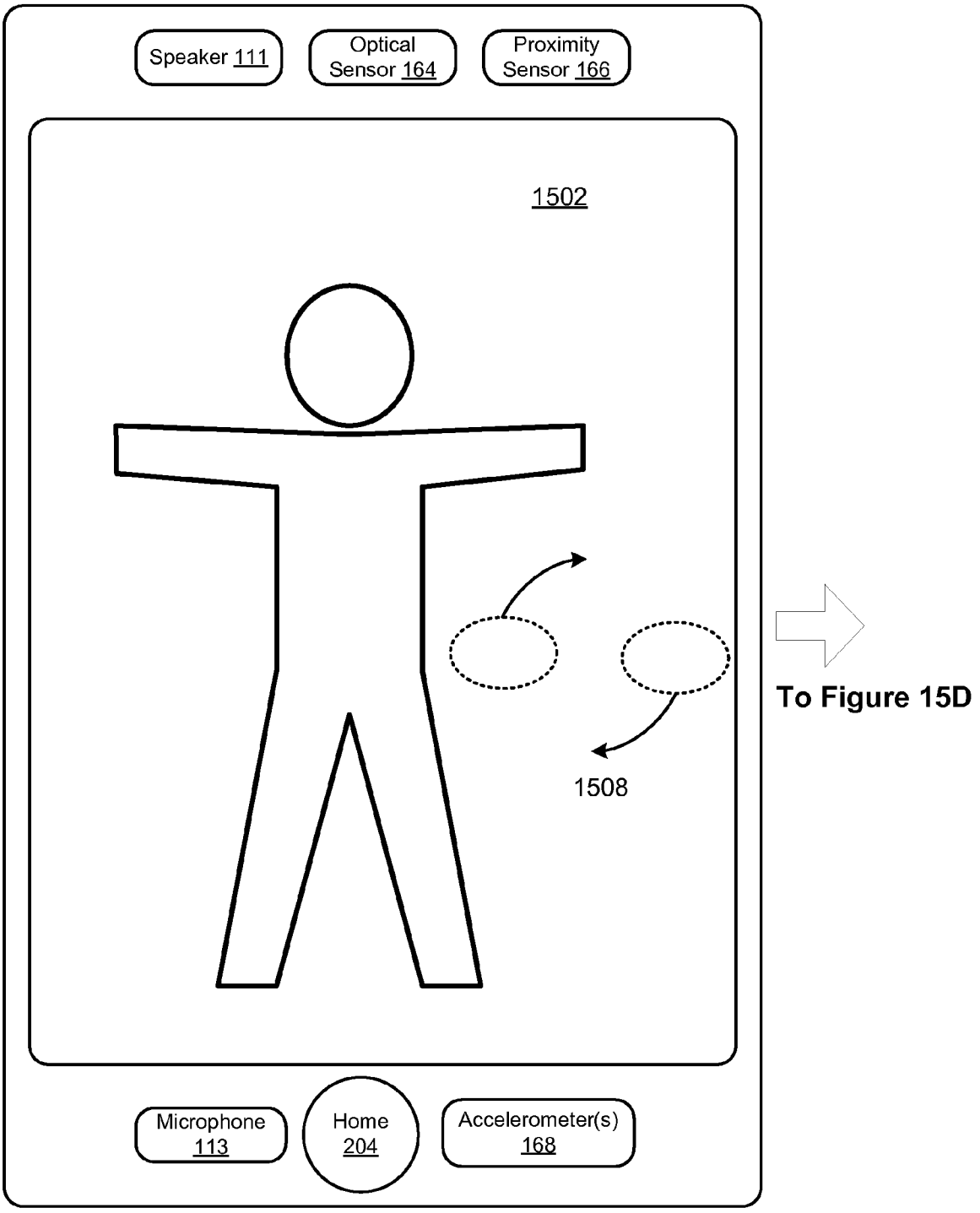
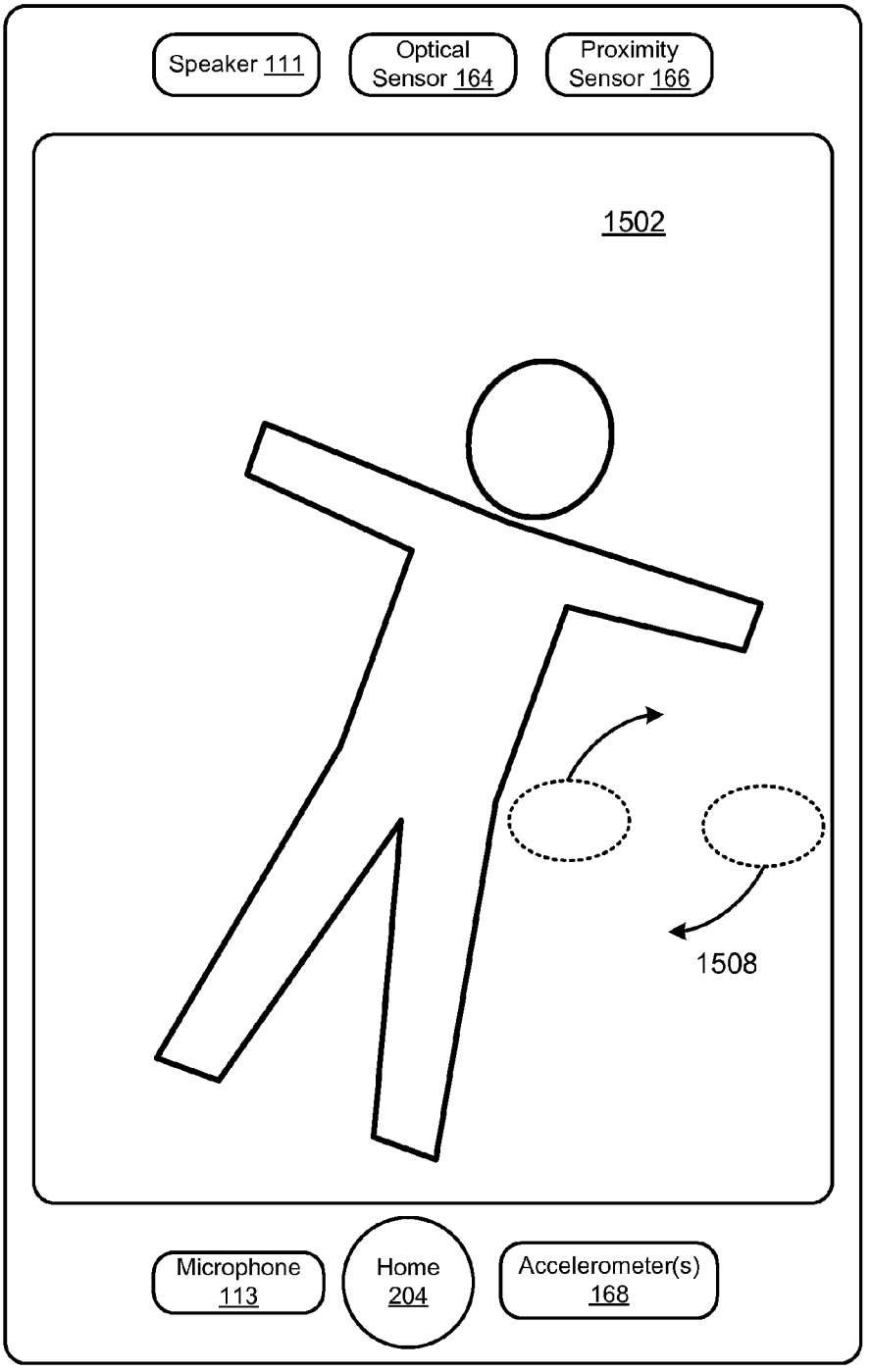

Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
1508
Microphone 113
Home 204
Accelerometer(s) 168
To Figure 15D

Figure 15C



To Figure 15E

Figure 15D

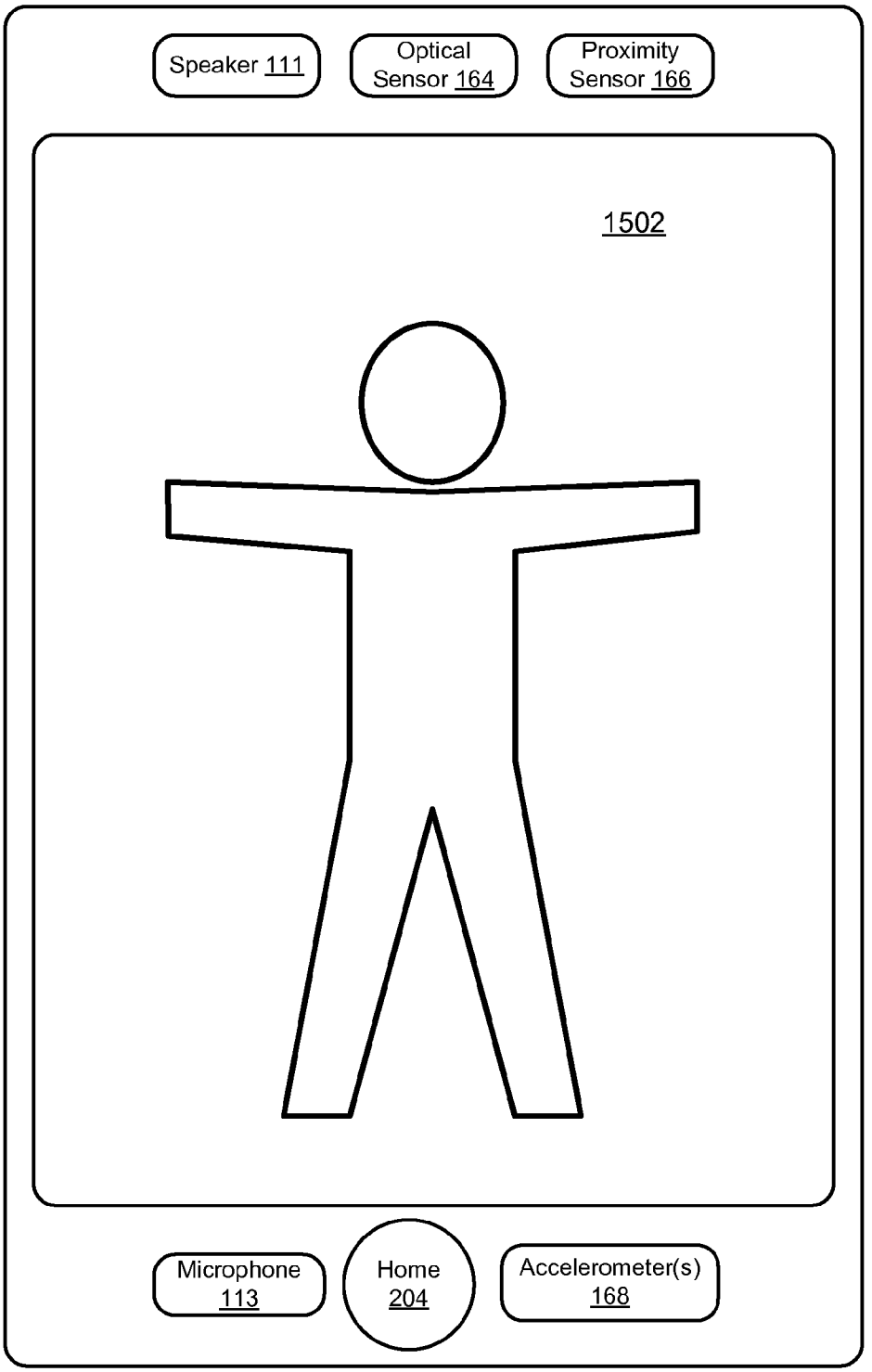

Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
Microphone 113
Home 204
Accelerometer(s) 168

Figure 15E

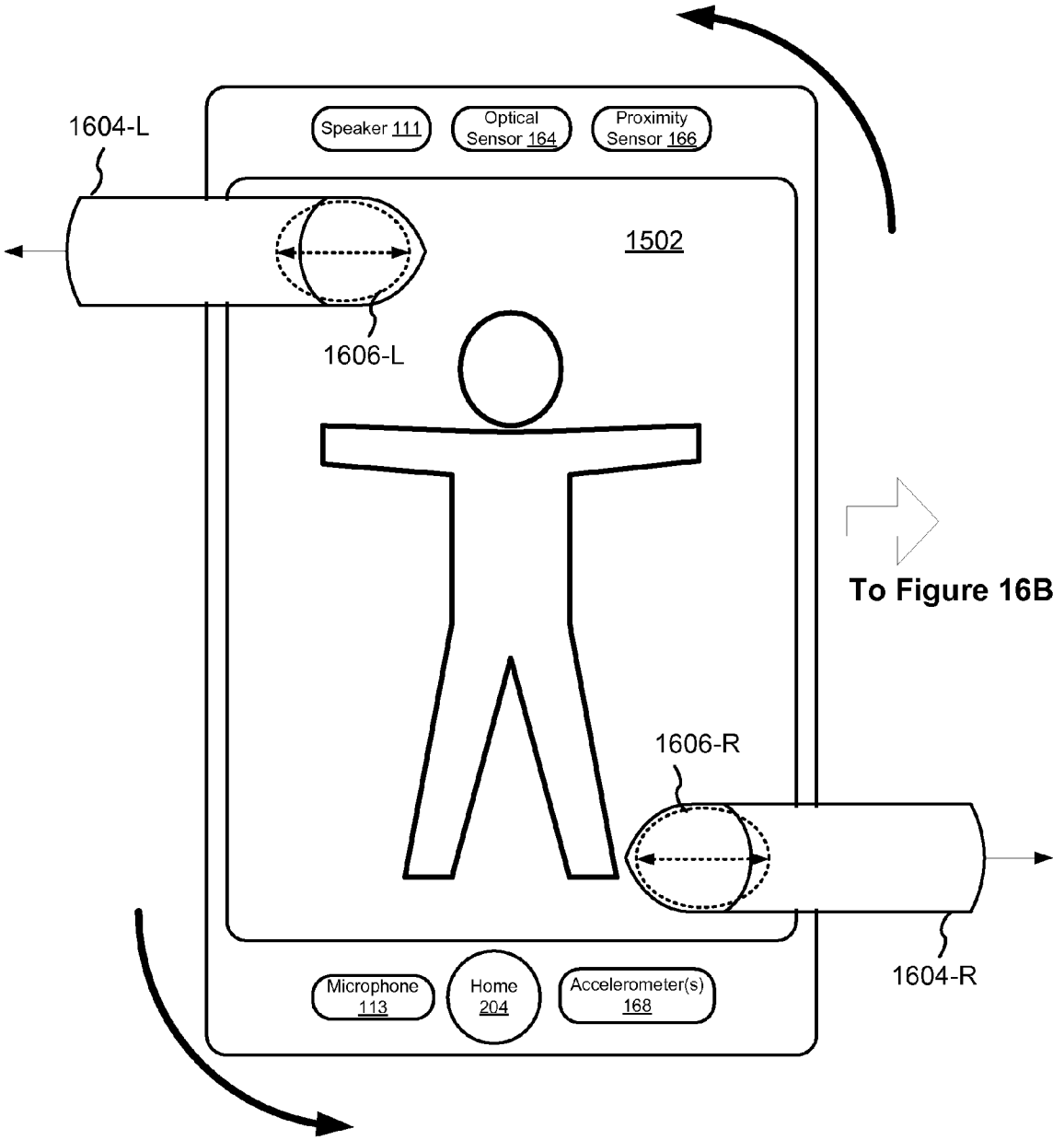

1604-L
Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
1606-L
To Figure 16B
1606-R
1604-R
Microphone 113
Home 204
Accelerometer(s) 168

Figure 16A

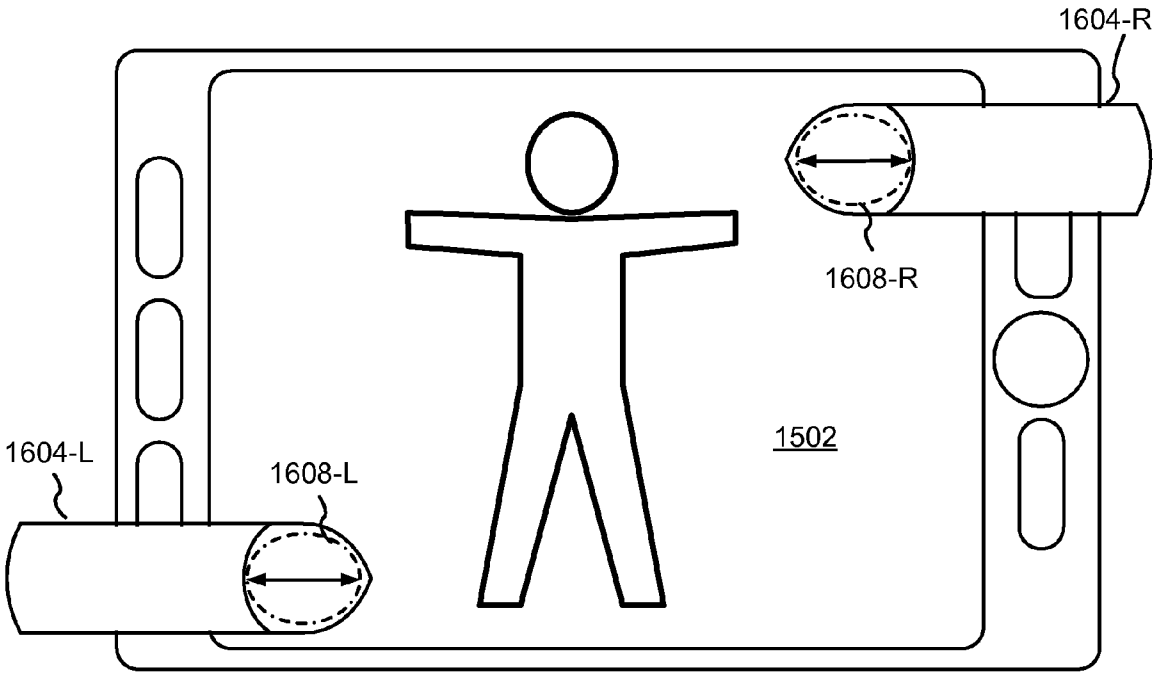


Figure 16B

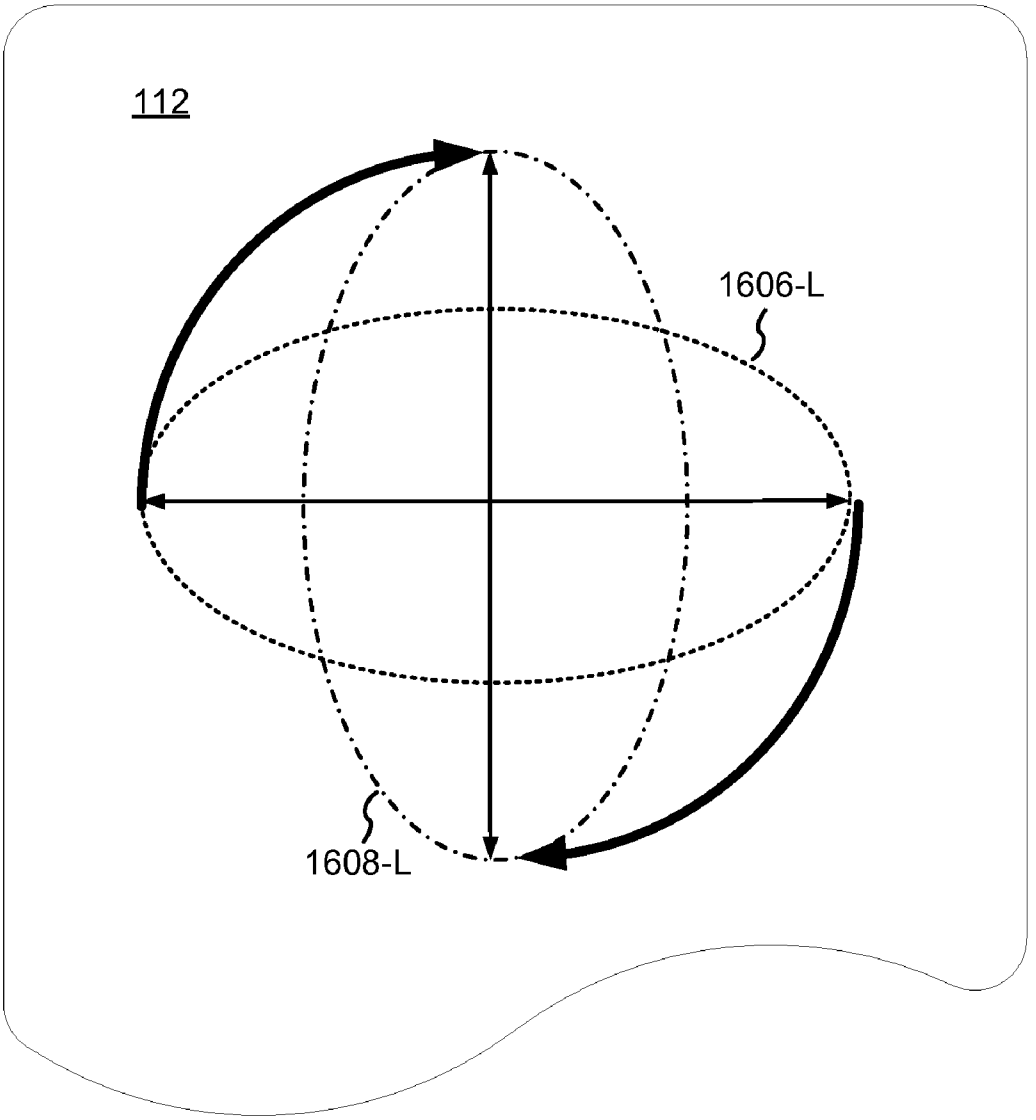


Figure 16C

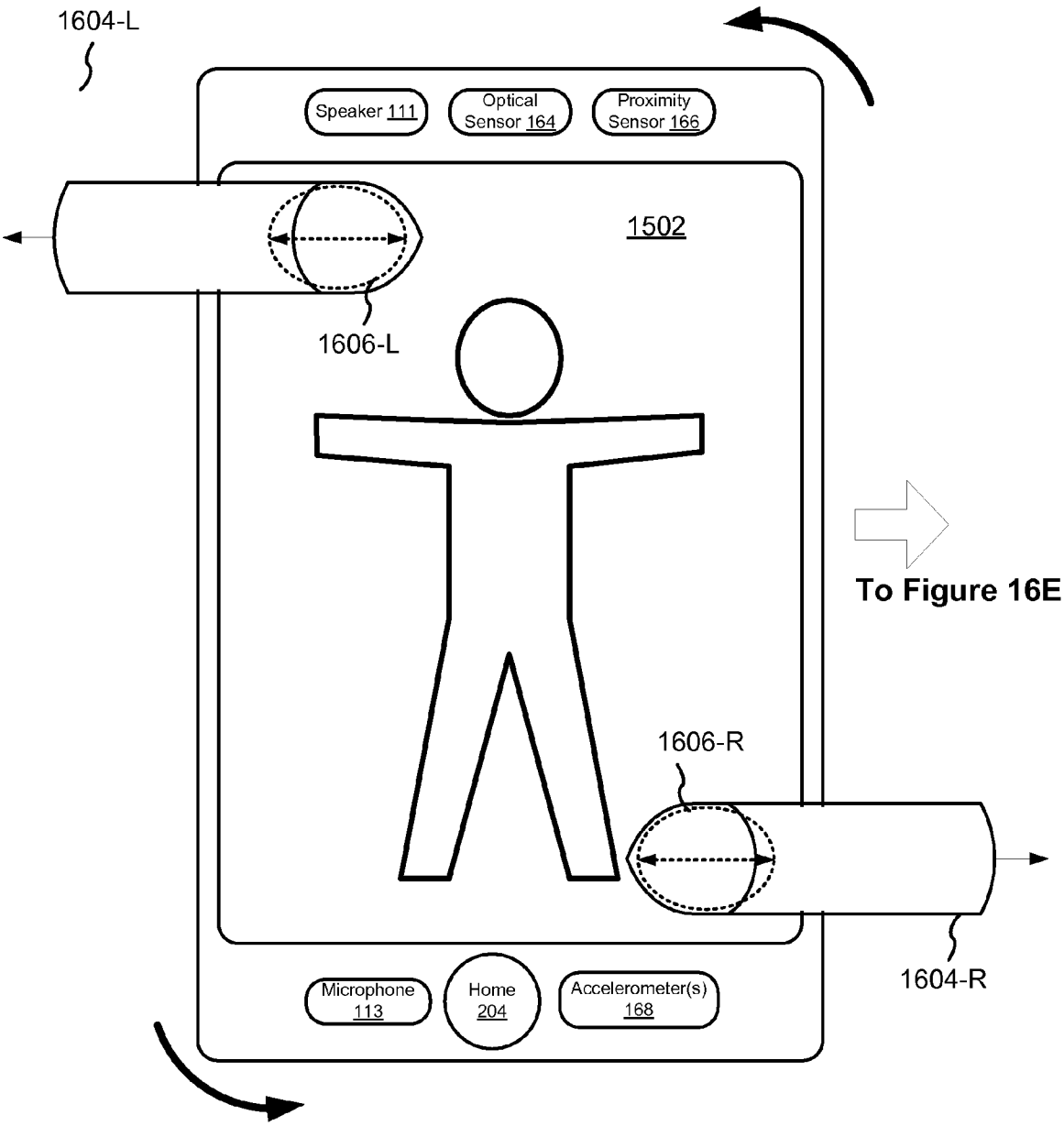

1604-L
Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
1606-L
To Figure 16E
1606-R
1604-R
Microphone 113
Home 204
Accelerometer(s) 168

Figure 16D

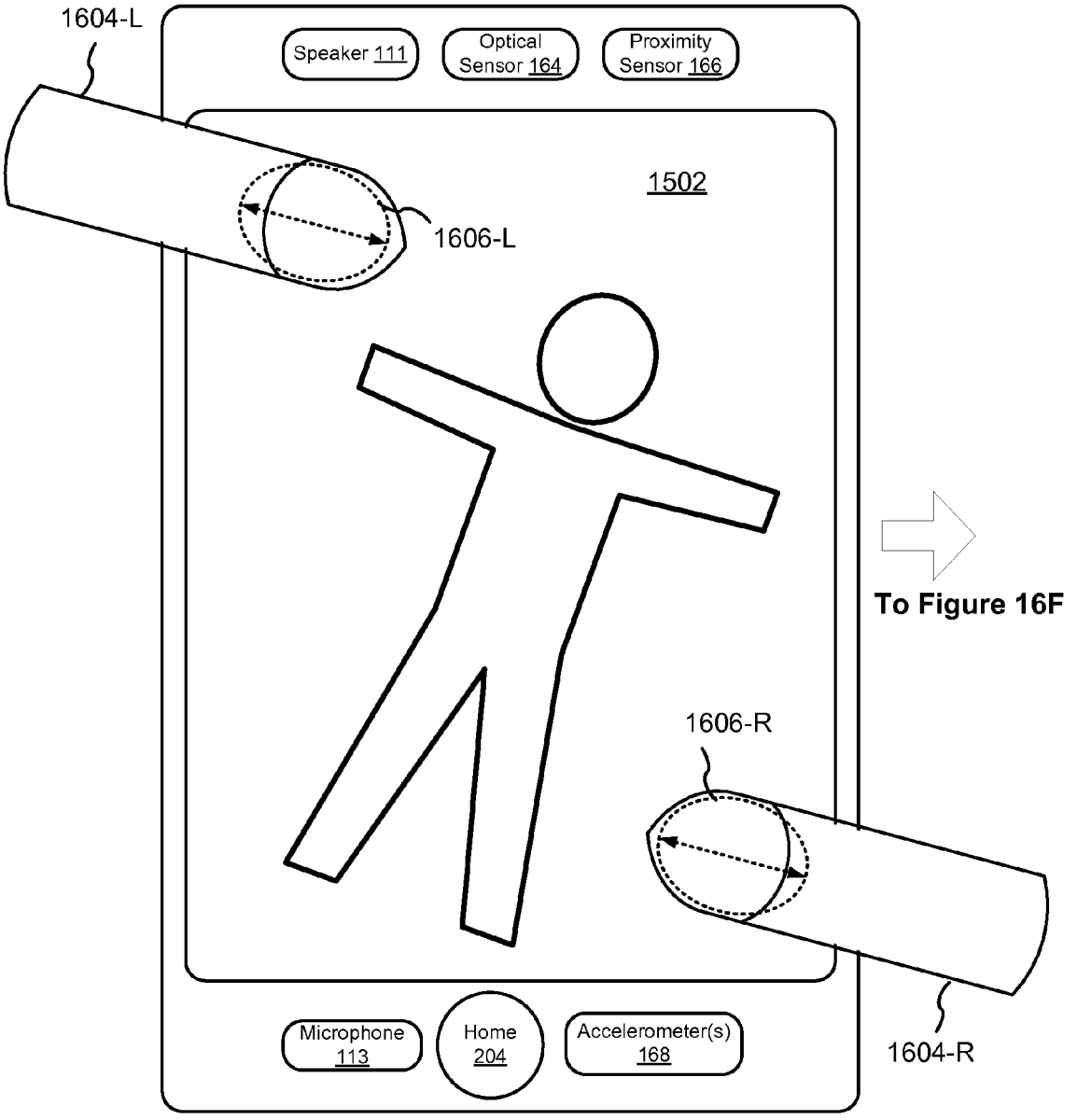

1604-L
Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
1606-L
To Figure 16F
1606-R
Microphone 113
Home 204
Accelerometer(s) 168
1604-R

Figure 16E

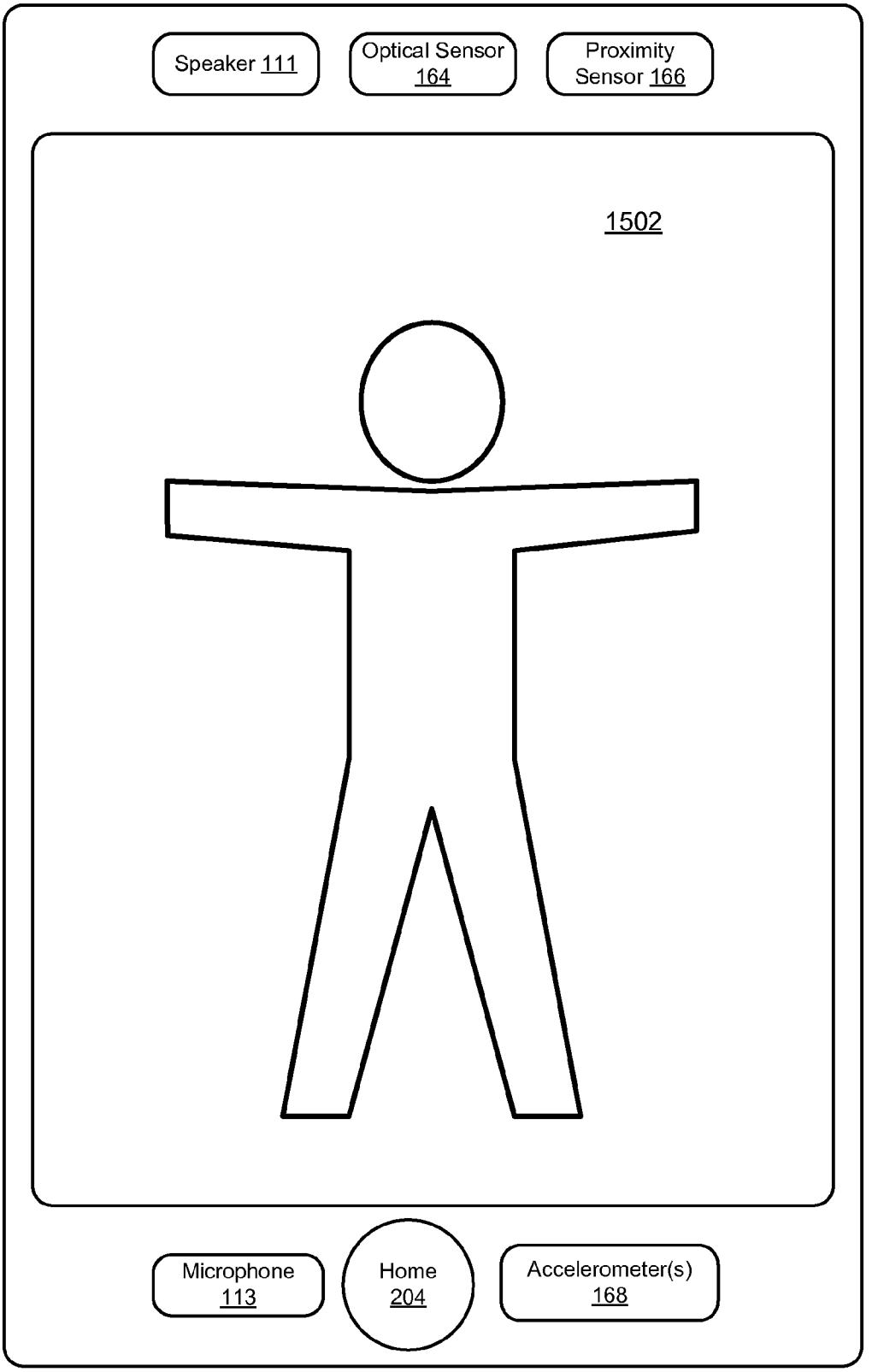

Speaker 111
Optical Sensor 164
Proximity Sensor 166
1502
Microphone 113
Home 204
Accelerometer(s) 168

Figure 16F

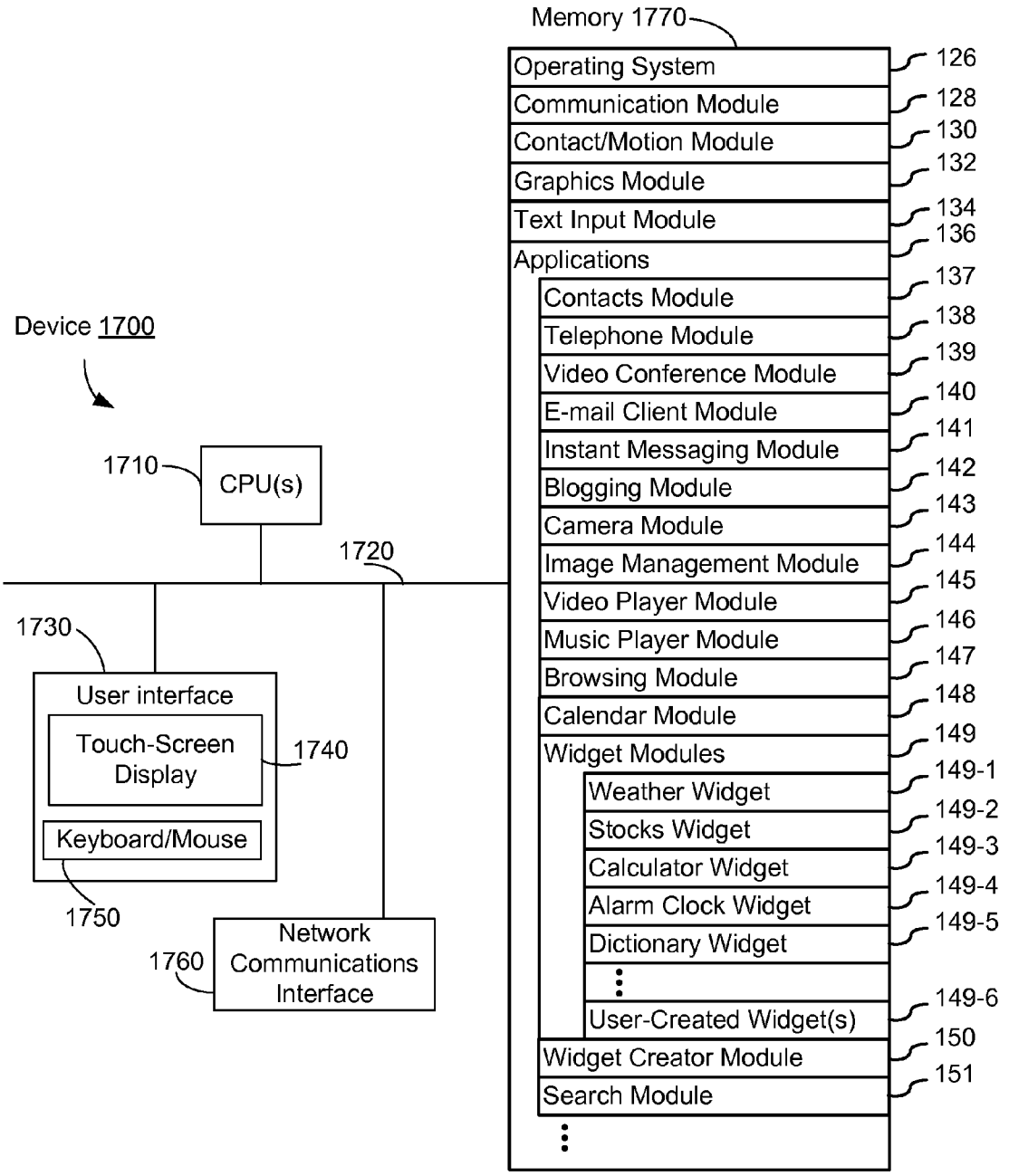

Memory 1770
Operating System
126
Communication Module
128
Contact/Motion Module
130
Graphics Module
132
Text Input Module
134
Applications
136
Contacts Module
137
Telephone Module
138
Video Conference Module
139
E-mail Client Module
140
Instant Messaging Module
141
Blogging Module
142
Camera Module
143
Image Management Module
144
Video Player Module
145
Music Player Module
146
Browsing Module
147
Calendar Module
148
Widget Modules
149
Weather Widget
149-1
Stocks Widget
149-2
Calculator Widget
149-3
Alarm Clock Widget
149-4
Dictionary Widget
149-5
User-Created Widget(s)
149-6
Widget Creator Module
150
Search Module
151
Device 1700
1710
CPU(s)
1720
1730
User interface
Touch-Screen Display
1740
Keyboard/Mouse
1750
1760
Network Communications Interface

Figure 17

LIST SCROLLING AND DOCUMENT TRANSLATION, SCALING, AND ROTATION ON A TOUCH-SCREEN DISPLAY

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application Nos. 60/937,993, "Portable Multifunction Device," filed Jun. 29, 2007; 60/946,971, "List Scrolling and Document Translation, Scaling, and Rotation on a Touch-Screen Display," filed Jun. 28, 2007; 60/945,858, "List Scrolling and Document Translation on a Touch-Screen Display," filed Jun. 22, 2007; 60/879,469, "Portable Multifunction Device," filed Jan. 8, 2007; 60/883,801, "List Scrolling and Document Translation on a Touch-Screen Display," filed Jan. 7, 2007; and 60/879,253, "Portable Multifunction Device," filed Jan. 7, 2007. All of these applications are incorporated by reference herein in their entirety.

This application is related to the following applications: (1) U.S. patent application Ser. No. 10/188,182, "Touch Pad For Handheld Device," filed on Jul. 1, 2002; (2) U.S. patent application Ser. No. 10/722,948, "Touch Pad For Handheld Device," filed on Nov. 25, 2003; (3) U.S. patent application Ser. No. 10/643,256, "Movable Touch Pad With Added Functionality," filed on Aug. 18, 2003; (4) U.S. patent application Ser. No. 10/654,108, "Ambidextrous Mouse," filed on Sep. 2, 2003; (5) U.S. patent application Ser. No. 10/840,862, "Multipoint Touchscreen," filed on May 6, 2004; (6) U.S. patent application Ser. No. 10/903,964, "Gestures For Touch Sensitive Input Devices," filed on Jul. 30, 2004; (7) U.S. patent application Ser. No. 11/038,590, "Mode-Based Graphical User Interfaces For Touch Sensitive Input Devices" filed on Jan. 18, 2005; (8) U.S. patent application Ser. No. 11/057,050, "Display Actuator," filed on Feb. 11, 2005; (9) U.S. Provisional Patent Application No. 60/658,777, "Multi-Functional Hand-Held Device," filed Mar. 4, 2005; (10) U.S. patent application Ser. No. 11/367,749, "Multi-Functional Hand-Held Device," filed Mar. 3, 2006; and (11) U.S. Provisional Patent Application No. 60/824,769, "Portable Multifunction Device," filed Sep. 6, 2006. All of these applications are incorporated by reference herein in their entirety.

TECHNICAL FIELD

The disclosed embodiments relate generally to devices with touch-screen displays, and more particularly to scrolling lists and to translating, rotating, and scaling electronic documents on devices with touch-screen displays.

BACKGROUND

As portable electronic devices become more compact, and the number of functions performed by a given device increases, it has become a significant challenge to design a user interface that allows users to easily interact with a multifunction device. This challenge is particularly significant for handheld portable devices, which have much smaller screens than desktop or laptop computers. This situation is unfortunate because the user interface is the gateway through which users receive not only content but also responses to user actions or behaviors, including user attempts to access a device's features, tools, and functions. Some portable communication devices (e.g., mobile telephones, sometimes called mobile phones, cell phones, cellular telephones, and the like) have resorted to adding more pushbuttons, increasing the density of push buttons, overloading the functions of pushbuttons, or using complex menu systems to allow a user

to access, store and manipulate data. These conventional user interfaces often result in complicated key sequences and menu hierarchies that must be memorized by the user.

Many conventional user interfaces, such as those that include physical pushbuttons, are also inflexible. This is unfortunate because it may prevent a user interface from being configured and/or adapted by either an application running on the portable device or by users. When coupled with the time consuming requirement to memorize multiple key sequences and menu hierarchies, and the difficulty in activating a desired pushbutton, such inflexibility is frustrating to most users.

As a result of the small size of display screens on portable electronic devices and the potentially large size of electronic files, frequently only a portion of a list or of an electronic document of interest to a user can be displayed on the screen at a given time. Users thus will frequently need to scroll displayed lists or to translate displayed electronic documents. Users also will need to rotate and to scale (i.e., magnify or de-magnify) displayed electronic documents. However, the limitations of conventional user interfaces can cause these actions to be awkward to perform.

Furthermore, scrolling displayed lists and translating electronic documents can be awkward on both portable and non-portable electronic devices with touch-screen displays. A user may become frustrated if the scrolling or translation does not reflect the user's intent. Similarly, a user may become frustrated if rotation and scaling of electronic documents does not reflect the user's intent.

Accordingly, there is a need for devices with touch-screen displays with more transparent and intuitive user interfaces for scrolling lists of items and for translating, rotating, and scaling electronic documents that are easy to use, configure, and/or adapt.

SUMMARY

The above deficiencies and other problems associated with user interfaces for portable devices and devices with touch-sensitive displays are reduced or eliminated by the disclosed device. In some embodiments, the device has a touch-sensitive display (also known as a "touch screen") with a graphical user interface (GUI), one or more processors, memory and one or more modules, programs or sets of instructions stored in the memory for performing multiple functions. In some embodiments, the user interacts with the GUI primarily through finger contacts and gestures on the touch-sensitive display. In some embodiments, the functions may include telephoning, video conferencing, e-mailing, instant messaging, blogging, digital photographing, digital videoing, web browsing, digital music playing, and/or digital video playing. Instructions for performing these functions may be included in a computer program product configured for execution by one or more processors.

In accordance with some embodiments, a computer-implemented method for use in conjunction with a device with a touch screen display is disclosed. In the method, a movement of an object on or near the touch screen display is detected. In response to detecting the movement, an electronic document displayed on the touch screen display is translated in a first direction. If an edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display, an area beyond the edge of the document is displayed. After the object is no longer detected on or near the touch

screen display, the document is translated in a second direction until the area beyond the edge of the document is no longer displayed.

In accordance with some embodiments, a graphical user interface on a device with a touch screen display is disclosed, comprising a portion of an electronic document displayed on the touch screen display and an area beyond an edge of the document. In the graphical user interface, in response to detecting a movement of an object on or near the touch screen display, the electronic document is translated in a first direction. If the edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display, the area beyond the edge of the document is displayed. After the object is no longer detected on or near the touch screen display, the document is translated in a second direction until the area beyond the edge of the document is no longer displayed.

In accordance with some embodiments, a device is disclosed, comprising a touch screen display, one or more processors, memory, and one or more programs. The one or more programs are stored in the memory and configured to be executed by the one or more processors. The one or more programs include instructions for detecting a movement of an object on or near the touch screen display and instructions for translating an electronic document displayed on the touch screen display in a first direction, in response to detecting the movement. The one or more programs also include instructions for displaying an area beyond an edge of the electronic document if the edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display. The one or more programs further include instructions for translating the document in a second direction until the area beyond the edge of the document is no longer displayed, after the object is no longer detected on or near the touch screen display.

In accordance with some embodiments, a computer-program product is disclosed, comprising a computer readable storage medium and a computer program mechanism embedded therein. The computer program mechanism comprises instructions, which when executed by a device with a touch screen display, cause the device to detect a movement of an object on or near the touch screen display and to translate an electronic document displayed on the touch screen display in a first direction, in response to detecting the movement. The instructions also cause the device to display an area beyond an edge of the electronic document if the edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display. The instructions further cause the device to translate the document in a second direction until the area beyond the edge of the document is no longer displayed, after the object is no longer detected on or near the touch screen display.

In accordance with some embodiments, a device with a touch screen display is disclosed. The device comprises means for detecting a movement of an object on or near the touch screen display and means for translating an electronic document displayed on the touch screen display in a first direction, in response to detecting the movement. The device also comprises means for displaying an area beyond an edge of the electronic document if the edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display. The device further comprises means for translating the document in a second direction until the area beyond the edge of the document is no longer displayed, after the object is no longer detected on or near the touch screen display.

In accordance with some embodiments, a computer-implemented method for use in conjunction with a device with a touch screen display is disclosed. In the method, a movement of an object on or near the touch screen display is detected. In response to detecting the movement, a list of items displayed on the touch screen display is scrolled in a first direction. If a terminus of the list is reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display, an area beyond the terminus of the list is displayed. After the object is no longer detected on or near the touch screen display, the list is scrolled in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed.

In accordance with some embodiments, a graphical user interface on a device with a touch screen display is disclosed, comprising a portion of a list of items displayed on the touch screen display and an area beyond a terminus of the list. In response to detecting a movement of an object on or near the touch screen display, the list is scrolled in a first direction. If the terminus of the list is reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display, the area beyond the terminus of the list is displayed. After the object is no longer detected on or near the touch screen display, the list is scrolled in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed.

In accordance with some embodiments, a device is disclosed, comprising a touch screen display, one or more processors, memory, and one or more programs. The one or more programs are stored in the memory and configured to be executed by the one or more processors. The one or more programs include instructions for detecting a movement of an object on or near the touch screen display and instructions for scrolling a list of items displayed on the touch screen display in a first direction in response to detecting the movement. The one or more programs also include instructions for displaying an area beyond a terminus of the list if the terminus of the list is reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display. The one or more programs further include instructions for scrolling the list in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed, after the object is no longer detected on or near the touch screen display.

In accordance with some embodiments, a computer-program product is disclosed, comprising a computer readable storage medium and a computer program mechanism embedded therein. The computer program mechanism comprises instructions, which when executed by a device with a touch screen display, cause the device to detect a movement of an object on or near the touch screen display and to scroll a list of items displayed on the touch screen display in a first direction in response to detecting the movement. The instructions also cause the device to display an area beyond a terminus of the list if the terminus of the list is reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display. The instructions further cause the device to scroll the list in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed, after the object is no longer detected on or near the touch screen display.

In accordance with some embodiments, a device with a touch screen display is disclosed. The device comprises means for detecting a movement of an object on or near the

touch screen display and means for scrolling a list of items displayed on the touch screen display in a first direction in response to detecting the movement. The device also comprises means for displaying an area beyond a terminus of the list if the terminus of the list is reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display. The device further comprises means for scrolling the list in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed, after the object is no longer detected on or near the touch screen display.

In accordance with some embodiments, a computer-implemented method for use at a device with a touch screen display includes detecting a multifinger twisting gesture on or near the touch screen display. The multifinger twisting gesture has a corresponding degree of rotation. If the corresponding degree of rotation exceeds a predefined degree of rotation, a 90° screen rotation command is executed. If the corresponding degree of rotation is less than the predefined degree of rotation, a screen rotation command with an acute angle of rotation is executed and, upon ceasing to detect the multifinger twisting gesture, a screen rotation command with an angle of rotation opposite to the acute angle is executed.

In accordance with some embodiments, a device includes a touch screen display, one or more processors, memory, and one or more programs. The one or more programs are stored in the memory and configured to be executed by the one or more processors. The one or more programs include: instructions for detecting a multifinger twisting gesture on or near the touch screen display, wherein the multifinger twisting gesture has a corresponding degree of rotation; instructions for executing a 90° screen rotation command, if the corresponding degree of rotation exceeds a predefined degree of rotation; and instructions for executing a screen rotation command with an acute angle of rotation and for executing, upon ceasing to detect the multifinger twisting gesture, a screen rotation command with an angle of rotation opposite to the acute angle, if the corresponding degree of rotation is less than the predefined degree of rotation.

In accordance with some embodiments, a computer-program product includes a computer readable storage medium and a computer program mechanism embedded therein. The computer program mechanism includes instructions, which when executed by a device with a touch screen display, cause the device to: detect a multifinger twisting gesture on or near the touch screen display, wherein the multifinger twisting gesture has a corresponding degree of rotation; execute a 90° screen rotation command, if the corresponding degree of rotation exceeds a predefined degree of rotation; and execute a screen rotation command with an acute angle of rotation and, upon ceasing to detect the multifinger twisting gesture, execute a screen rotation command with an angle of rotation opposite to the acute angle, if the corresponding degree of rotation is less than the predefined degree of rotation.

In accordance with some embodiments, a device with a touch screen display includes: means for detecting a multifinger twisting gesture on or near the touch screen display, wherein the multifinger twisting gesture has a corresponding degree of rotation; means for executing a 90° screen rotation command, if the corresponding degree of rotation exceeds a predefined degree of rotation; and means for executing a screen rotation command with an acute angle of rotation and, upon ceasing to detect the multifinger twisting gesture, for executing a screen rotation command with an angle of rotation opposite to the acute angle, if the corresponding degree of rotation is less than the predefined degree of rotation.

In accordance with some embodiments, a computer-implemented method of displaying an electronic document having a document length and a document width, for use at a device with a touch screen display, includes displaying the electronic document at a first magnification and detecting a gesture on or near the touch screen display corresponding to a command to zoom out by a user-specified amount. In response to detecting the gesture, the electronic document is displayed at a magnification less than the first magnification. If the document length or document width is entirely displayed while the gesture is still detected on or near the touch screen display, the electronic document is displayed at a magnification wherein areas beyond opposite edges of the electronic document are displayed, and upon detecting termination of the gesture, the electronic document is displayed at a magnification wherein the areas beyond opposite edges of the electronic document are no longer displayed.

In accordance with some embodiments, a graphical user interface on a device with a touch screen display includes an electronic document having a document length and a document width, to be displayed on the touch screen display at multiple magnifications including a first magnification, and areas beyond opposite edges of the electronic document. In response to detecting a gesture on or near the touch screen display corresponding to a command to zoom out by a user-specified amount, wherein the gesture is detected while displaying the electronic document at the first magnification, the electronic document is displayed at a magnification less than the first magnification. If the document length or document width is entirely displayed while the gesture is still detected on or near the touch screen display, the electronic document is displayed at a magnification wherein the areas beyond opposite edges of the electronic document are displayed, and upon detecting termination of the gesture, the electronic document is displayed at a magnification wherein the areas beyond opposite edges of the electronic document are no longer displayed.

In accordance with some embodiments, a device includes a touch screen display, one or more processors, memory, and one or more programs. The one or more programs are stored in the memory and configured to be executed by the one or more processors. The one or more programs include: instructions for displaying an electronic document at a first magnification; instructions for detecting a gesture on or near the touch screen display corresponding to a command to zoom out by a user-specified amount; instructions for displaying the electronic document at a magnification less than the first magnification, in response to detecting the gesture; instructions for displaying the electronic document at a magnification wherein areas beyond opposite edges of the electronic document are displayed, if a document length or a document width is entirely displayed while the gesture is still detected on or near the touch screen display; and instructions for displaying the electronic document at a magnification wherein the areas beyond opposite edges of the electronic document are no longer displayed, upon detecting termination of the gesture.

In accordance with some embodiments, a computer-program product includes a computer readable storage medium and a computer program mechanism embedded therein. The computer program mechanism includes instructions, which when executed by a device with a touch screen display, cause the device to: display an electronic document at a first magnification; detect a gesture on or near the touch screen display corresponding to a command to zoom out by a user-specified amount; display the electronic document at a magnification less than the first magnification, in response to detecting the

gesture; display the electronic document at a magnification wherein areas beyond opposite edges of the electronic document are displayed, if a document length or a document width is entirely displayed while the gesture is still detected on or near the touch screen display; and display the electronic document at a magnification wherein the areas beyond opposite edges of the electronic document are no longer displayed, upon detecting termination of the gesture.

In accordance with some embodiments, a device with a touch screen display includes: means for displaying an electronic document at a first magnification; means for detecting a gesture on or near the touch screen display corresponding to a command to zoom out by a user-specified amount; means for displaying the electronic document at a magnification less than the first magnification, in response to detecting the gesture; means for displaying the electronic document at a magnification wherein areas beyond opposite edges of the electronic document are displayed, if a document length or a document width is entirely displayed while the gesture is still detected on or near the touch screen display; and means for displaying the electronic document at a magnification wherein the areas beyond opposite edges of the electronic document are no longer displayed, upon detecting termination of the gesture.

In accordance with some embodiments, a computer-implemented method of displaying an electronic document, for use at a device with a touch screen display, includes displaying at least a first portion of the electronic document at a first magnification and detecting a gesture on or near the touch screen display corresponding to a command to zoom in by a user-specified amount. In response to detecting the gesture, decreasing portions of the electronic document are displayed at increasing magnifications. Upon detecting termination of the gesture, if the magnification exceeds a predefined magnification, a respective portion of the electronic document is displayed at the predefined magnification.

In accordance with some embodiments, a graphical user interface on a device with a touch screen display includes decreasing portions of an electronic document, to be displayed on the touch screen display at increasing magnifications. The decreasing portions of the electronic document include a first portion. In response to detecting a gesture on or near the touch screen display corresponding to a command to zoom in by a user-specified amount, wherein the gesture is detected while displaying at least the first portion of an electronic document at a first magnification, the decreasing portions of the electronic document are displayed at the increasing magnifications. Upon detecting termination of the gesture, if the magnification exceeds a predefined magnification, a respective portion of the electronic document is displayed at the predefined magnification.

In accordance with some embodiments, a device includes a touch screen display, one or more processors, memory, and one or more programs. The one or more programs are stored in the memory and configured to be executed by the one or more processors. The one or more programs include: instructions for displaying at least a first portion of an electronic document at a first magnification; instructions for detecting a gesture on or near the touch screen display corresponding to a command to zoom in by a user-specified amount; instructions for displaying decreasing portions of the electronic document at increasing magnifications, in response to detecting the gesture; and instructions for displaying a respective portion of the electronic document at a predefined magnification if, upon detecting termination of the gesture, the magnification exceeds the predefined magnification.

In accordance with some embodiments, a computer-program product includes a computer readable storage medium and a computer program mechanism embedded therein. The computer program mechanism includes instructions, which when executed by a device with a touch screen display, cause the device to: display at least a first portion of an electronic document at a first magnification; detect a gesture on or near the touch screen display corresponding to a command to zoom in by a user-specified amount; display decreasing portions of the electronic document at increasing magnifications, in response to detecting the gesture; and display a respective portion of the electronic document at a predefined magnification if, upon detecting termination of the gesture, the magnification exceeds a predefined magnification.

In accordance with some embodiments, a device with a touch screen display includes means for displaying at least a first portion of an electronic document at a first magnification; means for detecting a gesture on or near the touch screen display corresponding to a command to zoom in by a user-specified amount; means for displaying decreasing portions of the electronic document at increasing magnifications, in response to detecting the gesture; and means for displaying a respective portion of the electronic document at a predefined magnification if, upon detecting termination of the gesture, the magnification exceeds the predefined magnification.

The disclosed embodiments provide for easy and intuitive scrolling of lists and translating of electronic documents on a device with a touch screen display, and for easy and intuitive rotation and scaling of electronic documents on a device with a touch screen display.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the aforementioned embodiments of the invention as well as additional embodiments thereof, reference should be made to the Description of Embodiments below, in conjunction with the following drawings in which like reference numerals refer to corresponding parts throughout the figures.

FIG. **1** is a block diagram illustrating a portable multifunction device with a touch-sensitive display in accordance with some embodiments.

FIG. **2** illustrates a portable multifunction device having a touch screen in accordance with some embodiments.

FIG. **3** illustrates an exemplary user interface for unlocking a portable electronic device in accordance with some embodiments.

FIG. **4** illustrates an exemplary user interface for a menu of applications on a portable multifunction device in accordance with some embodiments.

FIG. **5** is a flow diagram illustrating a method of scrolling through a list in accordance with some embodiments.

FIGS. **6**A-**6**D illustrate an exemplary user interface for managing an inbox in accordance with some embodiments.

FIG. **7** is a flow diagram illustrating a method of translating an electronic document in accordance with some embodiments.

FIGS. **8**A-**8**D illustrate an exemplary user interface for a browser in accordance with some embodiments.

FIG. **9** is a flow diagram illustrating a process of displaying an electronic document at multiple magnifications in accordance with some embodiments.

FIGS. **10**A-**10**C illustrate the display of an electronic document at multiple magnifications in accordance with some embodiments.

FIG. **11** is a flow diagram illustrating a process of displaying an electronic document at multiple magnifications in accordance with some embodiments.

FIGS. **12**A-**12**C illustrate the display of an electronic document at multiple magnifications in accordance with some embodiments.

FIGS. **13**A-**13**C illustrate the display of an electronic document at multiple magnifications in accordance with some embodiments.

FIG. **14** is a flow diagram illustrating a process of executing a screen rotation command in accordance with some embodiments.

FIGS. **15**A-**15**E illustrate rotating the display of an electronic document or other digital object in accordance with some embodiments.

FIGS. **16**A-**16**F illustrate an exemplary screen rotation gesture in accordance with some embodiments.

FIG. **17** is a block diagram illustrating a device with a touch-screen display in accordance with some embodiments.

DESCRIPTION OF EMBODIMENTS

Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, circuits, and networks have not been described in detail so as not to unnecessarily obscure aspects of the embodiments.

Embodiments of a portable multifunction device, user interfaces for such devices, and associated processes for using such devices are described. In some embodiments, the device is a portable communications device such as a mobile telephone that also contains other functions, such as PDA and/or music player functions.

The user interface may include a physical click wheel in addition to a touch screen or a virtual click wheel displayed on the touch screen. A click wheel is a user-interface device that may provide navigation commands based on an angular displacement of the wheel or a point of contact with the wheel by a user of the device. A click wheel may also be used to provide a user command corresponding to selection of one or more items, for example, when the user of the device presses down on at least a portion of the wheel or the center of the wheel. Alternatively, breaking contact with a click wheel image on a touch screen surface may indicate a user command corresponding to selection. For simplicity, in the discussion that follows, a portable multifunction device that includes a touch screen is used as an exemplary embodiment. It should be understood, however, that some of the user interfaces and associated processes may be applied to other devices, such as personal computers and laptop computers, that may include one or more other physical user-interface devices, such as a physical click wheel, a physical keyboard, a mouse and/or a joystick.

The device supports a variety of applications, such as a telephone application, a video conferencing application, an e-mail application, an instant messaging application, a blogging application, a digital camera application, a digital video camera application, a web browsing application, a digital music player application, and/or a digital video player application.

The various applications that may be executed on the device may use at least one common physical user-interface device, such as the touch screen. One or more functions of the touch screen as well as corresponding information displayed on the device may be adjusted and/or varied from one application to the next and/or within a respective application. In this way, a common physical architecture (such as the touch screen) of the device may support the variety of applications with user interfaces that are intuitive and transparent.

The user interfaces may include one or more soft keyboard embodiments. The soft keyboard embodiments may include standard (QWERTY) and/or non-standard configurations of symbols on the displayed icons of the keyboard, such as those described in U.S. patent applications Ser. No. 11/459,606, "Keyboards For Portable Electronic Devices," filed Jul. 24, 2006, and Ser. No. 11/459,615, "Touch Screen Keyboards For Portable Electronic Devices," filed Jul. 24, 2006, the contents of which are hereby incorporated by reference herein in their entirety. The keyboard embodiments may include a reduced number of icons (or soft keys) relative to the number of keys in existing physical keyboards, such as that for a typewriter. This may make it easier for users to select one or more icons in the keyboard, and thus, one or more corresponding symbols. The keyboard embodiments may be adaptive. For example, displayed icons may be modified in accordance with user actions, such as selecting one or more icons and/or one or more corresponding symbols. One or more applications on the portable device may utilize common and/or different keyboard embodiments. Thus, the keyboard embodiment used may be tailored to at least some of the applications. In some embodiments, one or more keyboard embodiments may be tailored to a respective user. For example, based on a word usage history (lexicography, slang, individual usage) of the respective user. Some of the keyboard embodiments may be adjusted to reduce a probability of a user error when selecting one or more icons, and thus one or more symbols, when using the soft keyboard embodiments.

Attention is now directed towards embodiments of the device. FIG. **1** is a block diagram illustrating a portable multifunction device **100** with a touch-sensitive display **112** in accordance with some embodiments. The touch-sensitive display **112** is sometimes called a "touch screen" for convenience. The device **100** may include a memory **102** (which may include one or more computer readable storage mediums), a memory controller **122**, one or more processing units (CPU's) **120**, a peripherals interface **118**, RF circuitry **108**, audio circuitry **110**, a speaker **111**, a microphone **113**, an input/output (I/O) subsystem **106**, other input or control devices **116**, and an external port **124**. The device **100** may include one or more optical sensors **164**. These components may communicate over one or more communication buses or signal lines **103**.

It should be appreciated that the device **100** is only one example of a portable multifunction device **100**, and that the device **100** may have more or fewer components than shown, may combine two or more components, or a may have a different configuration or arrangement of the components. The various components shown in FIG. **1** may be implemented in hardware, software or a combination of both hardware and software, including one or more signal processing and/or application specific integrated circuits.

Memory **102** may include high-speed random access memory and may also include non-volatile memory, such as one or more magnetic disk storage devices, flash memory devices, or other non-volatile solid-state memory devices. Access to memory **102** by other components of the device **100**, such as the CPU **120** and the peripherals interface **118**, may be controlled by the memory controller **122**.

The peripherals interface **118** couples the input and output peripherals of the device to the CPU **120** and memory **102**. The one or more processors **120** run or execute various software programs and/or sets of instructions stored in memory **102** to perform various functions for the device **100** and to process data.

In some embodiments, the peripherals interface **118**, the CPU **120**, and the memory controller **122** may be implemented on a single chip, such as a chip **104**. In some other embodiments, they may be implemented on separate chips.

The RF (radio frequency) circuitry **108** receives and sends RF signals, also called electromagnetic signals. The RF circuitry **108** converts electrical signals to/from electromagnetic signals and communicates with communications networks and other communications devices via the electromagnetic signals. The RF circuitry **108** may include well-known circuitry for performing these functions, including but not limited to an antenna system, an RF transceiver, one or more amplifiers, a tuner, one or more oscillators, a digital signal processor, a CODEC chipset, a subscriber identity module (SIM) card, memory, and so forth. The RF circuitry **108** may communicate with networks, such as the Internet, also referred to as the World Wide Web (WWW), an intranet and/or a wireless network, such as a cellular telephone network, a wireless local area network (LAN) and/or a metropolitan area network (MAN), and other devices by wireless communication. The wireless communication may use any of a plurality of communications standards, protocols and technologies, including but not limited to Global System for Mobile Communications (GSM), Enhanced Data GSM Environment (EDGE), wideband code division multiple access (W-CDMA), code division multiple access (CDMA), time division multiple access (TDMA), Bluetooth, Wireless Fidelity (Wi-Fi) (e.g., IEEE 802.11a, IEEE 802.11b, IEEE 802.11g and/or IEEE 802.11n), voice over Internet Protocol (VoIP), Wi-MAX, a protocol for email, instant messaging, and/or Short Message Service (SMS)), or any other suitable communication protocol, including communication protocols not yet developed as of the filing date of this document.

The audio circuitry **110**, the speaker **111**, and the microphone **113** provide an audio interface between a user and the device **100**. The audio circuitry **110** receives audio data from the peripherals interface **118**, converts the audio data to an electrical signal, and transmits the electrical signal to the speaker **111**. The speaker **111** converts the electrical signal to human-audible sound waves. The audio circuitry **110** also receives electrical signals converted by the microphone **113** from sound waves. The audio circuitry **110** converts the electrical signal to audio data and transmits the audio data to the peripherals interface **118** for processing. Audio data may be retrieved from and/or transmitted to memory **102** and/or the RF circuitry **108** by the peripherals interface **118**. In some embodiments, the audio circuitry **110** also includes a headset jack (not shown). The headset jack provides an interface between the audio circuitry **110** and removable audio input/output peripherals, such as output-only headphones or a headset with both output (e.g., a headphone for one or both ears) and input (e.g., a microphone).

The I/O subsystem **106** couples input/output peripherals on the device **100**, such as the display system **112** and other input/control devices **116**, to the peripherals interface **118**. The I/O subsystem **106** may include a display controller **156** and one or more input controllers **160** for other input or control devices. The one or more input controllers **160** receive/send electrical signals from/to other input or control devices **116**. The other input/control devices **116** may include physical buttons (e.g., push buttons, rocker buttons, etc.), dials, slider switches, joysticks, click wheels, and so forth. In some alternate embodiments, input controller(s) **160** may be coupled to any (or none) of the following: a keyboard, infrared port, USB port, and a pointer device such as a mouse. The one or more buttons (e.g., **208**, FIG. **2**) may include an up/down button for volume control of the speaker **111** and/or the microphone **113**. The one or more buttons may include a push button (e.g., **206**, FIG. **2**). A quick press of the push button may disengage a lock of the touch screen **112** or begin a process that uses gestures on the touch screen to unlock the device, as described in U.S. patent application Ser. No. 11/322,549, "Unlocking a Device by Performing Gestures on an Unlock Image," filed Dec. 23, 2005, which is hereby incorporated by reference herein in its entirety. A longer press of the push button (e.g., **206**) may turn power to the device **100** on or off. The user may be able to customize a functionality of one or more of the buttons. The touch screen **112** is used to implement virtual or soft buttons and one or more soft keyboards.

The touch-sensitive display system **112** provides an input interface and an output interface between the device and a user. The display controller **156** receives and/or sends electrical signals from/to the display system **112**. The display system **112** displays visual output to the user. The visual output may include graphics, text, icons, video, and any combination thereof (collectively termed "graphics"). In some embodiments, some or all of the visual output may correspond to user-interface objects, further details of which are described below.

A touch screen in display system **112** is a touch-sensitive surface that accepts input from the user based on haptic and/or tactile contact. The display system **112** and the display controller **156** (along with any associated modules and/or sets of instructions in memory **102**) detect contact (and any movement or breaking of the contact) on the display system **112** and converts the detected contact into interaction with user-interface objects (e.g., one or more soft keys, icons, web pages or images) that are displayed on the touch screen. In an exemplary embodiment, a point of contact between a touch screen in the display system **112** and the user corresponds to a finger of the user.

The touch screen in the display system **112** may use LCD (liquid crystal display) technology, or LPD (light emitting polymer display) technology, although other display technologies may be used in other embodiments. The touch screen in the display system **112** and the display controller **156** may detect contact and any movement or breaking thereof using any of a plurality of touch sensing technologies now known or later developed, including but not limited to capacitive, resistive, infrared, and surface acoustic wave technologies, as well as other proximity sensor arrays or other elements for determining one or more points of contact with a touch screen in the display system **112**. A touch-sensitive display in some embodiments of the display system **112** may be analogous to the multi-touch sensitive tablets described in the following U.S. Pat. Nos. 6,323,846 (Westerman et al.), 6,570,557 (Westerman et al.), and/or 6,677,932 (Westerman), and/or U.S. Patent Publication 2002/0015024A1, each of which is hereby incorporated by reference herein in their entirety. However, a touch screen in the display system **112** displays visual output from the portable device **100**, whereas touch sensitive tablets do not provide visual output. The touch screen in the display system **112** may have a resolution in excess of 100 dpi. In an exemplary embodiment, the touch screen in the display system has a resolution of approximately 168 dpi. The user may make contact with the touch screen in the display system **112** using any suitable object or append-

age, such as a stylus, a finger, and so forth. In some embodiments, the user interface is designed to work primarily with finger-based contacts and gestures, which are much less precise than stylus-based input due to the larger area of contact of a finger on the touch screen. In some embodiments, the device translates the rough finger-based input into a precise pointer/cursor position or command for performing the actions desired by the user.

A touch-sensitive display in some embodiments of the display system **112** may be as described in the following applications: (1) U.S. patent application Ser. No. 11/381,313, "Multipoint Touch Surface Controller," filed on May 2, 2006; (2) U.S. patent application Ser. No. 10/840,862, "Multipoint Touchscreen," filed on May 6, 2004; (3) U.S. patent application Ser. No. 10/903,964, "Gestures For Touch Sensitive Input Devices," filed on Jul. 30, 2004; (4) U.S. patent application Ser. No. 11/048,264, "Gestures For Touch Sensitive Input Devices," filed on Jan. 31, 2005; (5) U.S. patent application Ser. No. 11/038,590, "Mode-Based Graphical User Interfaces For Touch Sensitive Input Devices," filed on Jan. 18, 2005; (6) U.S. patent application Ser. No. 11/228,758, "Virtual Input Device Placement On A Touch Screen User Interface," filed on Sep. 16, 2005; (7) U.S. patent application Ser. No. 11/228,700, "Operation Of A Computer With A Touch Screen Interface," filed on Sep. 16, 2005; (8) U.S. patent application Ser. No. 11/228,737, "Activating Virtual Keys Of A Touch-Screen Virtual Keyboard," filed on Sep. 16, 2005; and (9) U.S. patent application Ser. No. 11/367,749, "Multi-Functional Hand-Held Device," filed on Mar. 3, 2006. All of these applications are incorporated by reference herein in their entirety.

In some embodiments, in addition to the touch screen, the device **100** may include a touchpad (not shown) for activating or deactivating particular functions. In some embodiments, the touchpad is a touch-sensitive area of the device that, unlike the touch screen, does not display visual output. The touchpad may be a touch-sensitive surface that is separate from the touch screen in the display system **112** or an extension of the touch-sensitive surface formed by the touch screen.

In some embodiments, the device **100** may include a physical or virtual click wheel as an input control device **116**. A user may navigate among and interact with one or more graphical objects (henceforth referred to as icons) displayed in the display system **112** by rotating the click wheel or by moving a point of contact with the click wheel (e.g., where the amount of movement of the point of contact is measured by its angular displacement with respect to a center point of the click wheel). The click wheel may also be used to select one or more of the displayed icons. For example, the user may press down on at least a portion of the click wheel or an associated button. User commands and navigation commands provided by the user via the click wheel may be processed by an input controller **160** as well as one or more of the modules and/or sets of instructions in memory **102**. For a virtual click wheel, the click wheel and click wheel controller may be part of the display system **112** and the display controller **156**, respectively. For a virtual click wheel, the click wheel may be either an opaque or semitransparent object that appears and disappears on the touch screen display in response to user interaction with the device. In some embodiments, a virtual click wheel is displayed on the touch screen of a portable multifunction device and operated by user contact with the touch screen.

The device **100** also includes a power system **162** for powering the various components. The power system **162** may include a power management system, one or more power sources (e.g., battery, alternating current (AC)), a recharging system, a power failure detection circuit, a power converter or inverter, a power status indicator (e.g., a light-emitting diode (LED)) and any other components associated with the generation, management and distribution of power in portable devices.

The device **100** may also include one or more optical sensors **164**. FIG. **1** shows an optical sensor coupled to an optical sensor controller **158** in I/O subsystem **106**. The optical sensor **164** may include charge-coupled device (CCD) or complementary metal-oxide semiconductor (CMOS) phototransistors. The optical sensor **164** receives light from the environment, projected through one or more lens, and converts the light to data representing an image. In conjunction with an imaging module **143**, the optical sensor **164** may capture still images or video. In some embodiments, an optical sensor is located on the back of the device **100**, opposite the touch screen display **112** on the front of the device, so that the touch screen display may be used as a viewfinder for either still and/or video image acquisition. In some embodiments, an optical sensor is located on the front of the device so that the user's image may be obtained for videoconferencing while the user views the other video conference participants on the touch screen display. In some embodiments, the position of the optical sensor **164** can be changed by the user (e.g., by rotating the lens and the sensor in the device housing) so that a single optical sensor **164** may be used along with the touch screen display for both video conferencing and still and/or video image acquisition.

The device **100** may also include one or more proximity sensors **166**. FIG. **1** shows a proximity sensor **166** coupled to the peripherals interface **118**. Alternately, the proximity sensor **166** may be coupled to an input controller **160** in the I/O subsystem **106**. The proximity sensor **166** may perform as described in U.S. patent application Ser. Nos. 11/241,839, "Proximity Detector In Handheld Device," filed Sep. 30, 2005, and 11/240,788, "Proximity Detector In Handheld Device," filed Sep. 30, 2005, which are hereby incorporated by reference herein in their entirety. In some embodiments, the proximity sensor turns off and disables the touch screen **112** when the multifunction device is placed near the user's ear (e.g., when the user is making a phone call). In some embodiments, the proximity sensor keeps the screen off when the device is in the user's pocket, purse, or other dark area to prevent unnecessary battery drainage when the device is a locked state.

In some embodiments, the software components stored in memory **102** may include an operating system **126**, a communication module (or set of instructions) **128**, a contact/motion module (or set of instructions) **130**, a graphics module (or set of instructions) **132**, a text input module (or set of instructions) **134**, a Global Positioning System (GPS) module (or set of instructions) **135**, and applications (or set of instructions) **136**.

The operating system **126** (e.g., Darwin, RTXC, LINUX, UNIX, OS X, WINDOWS, or an embedded operating system such as VxWorks) includes various software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) and facilitates communication between various hardware and software components.

The communication module **128** facilitates communication with other devices over one or more external ports **124** and also includes various software components for handling data received by the RF circuitry **108** and/or the external port **124**. The external port **124** (e.g., Universal Serial Bus (USB), FIREWIRE, etc.) is adapted for coupling directly to other

devices or indirectly over a network (e.g., the Internet, wireless LAN, etc.). In some embodiments, the external port is a multi-pin (e.g., 30-pin) connector that is the same as, or similar to and/or compatible with the 30-pin connector used on iPod (trademark of Apple Computer, Inc.) devices.

The contact/motion module **130** may detect contact with the touch screen in the display system **112** (in conjunction with the display controller **156**) and other touch sensitive devices (e.g., a touchpad or physical click wheel). The contact/motion module **130** includes various software components for performing various operations related to detection of contact, such as determining if contact has occurred, determining if there is movement of the contact and tracking the movement across the touch screen in the display system **112**, and determining if the contact has been broken (i.e., if the contact has ceased). Determining movement of the point of contact may include determining speed (magnitude), velocity (magnitude and direction), and/or an acceleration (a change in magnitude and/or direction) of the point of contact. These operations may be applied to single contacts (e.g., one finger contacts) or to multiple simultaneous contacts (e.g., "multi-touch"/multiple finger contacts). In some embodiments, the contact/motion module **130** and the display controller **156** also detects contact on a touchpad. In some embodiments, the contact/motion module **130** detects movement of one or more objects on or near the touch screen and/or the touchpad. In some embodiments, the contact/motion module **130** and the controller **160** detects contact on a click wheel **116**.

The graphics module **132** includes various known software components for rendering and displaying graphics on the display system **112**, including components for changing the intensity of graphics that are displayed. As used herein, the term "graphics" includes any object that can be displayed to a user, including without limitation text, web pages, icons (such as user-interface objects including soft keys), digital images, videos, animations and the like.

The text input module **134**, which may be a component of graphics module **132**, provides soft keyboards for entering text in various applications (e.g., contacts **137**, e-mail **140**, IM **141**, blogging **142**, browser **147**, and any other application that needs text input).

The GPS module **135** determines the location of the device and provides this information for use in various applications (e.g., to telephone **138** for use in location-based dialing, to camera **143** and/or blogger **142** as picture/video metadata, and to applications that provide location-based services such as weather widgets, local yellow page widgets, and map/navigation widgets).

The applications **136** may include the following modules (or sets of instructions), or a subset or superset thereof:

- a contacts module **137** (sometimes called an address book or contact list);
- a telephone module **138**;
- a video conferencing module **139**;
- an e-mail client module **140**;
- an instant messaging (IM) module **141**;
- a blogging module **142**;
- a camera module **143** for still and/or video images;
- an image management module **144**;
- a video player module **145**;
- a music player module **146**;
- a browser module **147**;
- a calendar module **148**;
- widget modules **149**, which may include weather widget **149-1**, stocks widget **149-2**, calculator widget **149-3**, alarm clock widget **149-4**, dictionary widget **149-5**, and other widgets obtained by the user, as well as user-created widgets **149-6**;
- widget creator module **150** for making user-created widgets **149-6**; and/or search module **151**.

Examples of other applications **136** that may be stored in memory **102** include memo pad and other word processing applications, JAVA-enabled applications, encryption, digital rights management, voice recognition, and voice replication.

In conjunction with display system **112**, display controller **156**, contact module **130**, graphics module **132**, and text input module **134**, the contacts module **137** may be used to manage an address book or contact list, including: adding name(s) to the address book; deleting name(s) from the address book; associating telephone number(s), e-mail address(es), physical address(es) or other information with a name; associating an image with a name; categorizing and sorting names; providing telephone numbers or e-mail addresses to initiate and/or facilitate communications by telephone **138**, video conference **139**, e-mail **140**, or IM **141**; and so forth.

In conjunction with RF circuitry **108**, audio circuitry **110**, speaker **111**, microphone **113**, display system **112**, display controller **156**, contact module **130**, graphics module **132**, and text input module **134**, the telephone module **138** may be used to enter a sequence of characters corresponding to a telephone number, access one or more telephone numbers in the address book **137**, modify a telephone number that has been entered, dial a respective telephone number, conduct a conversation and disconnect or hang up when the conversation is completed. As noted above, the wireless communication may use any of a plurality of communications standards, protocols and technologies.

In conjunction with RF circuitry **108**, audio circuitry **110**, speaker **111**, microphone **113**, display system **112**, display controller **156**, optical sensor **164**, optical sensor controller **158**, contact module **130**, graphics module **132**, text input module **134**, contact list **137**, and telephone module **138**, the videoconferencing module **139** may be used to initiate, conduct, and terminate a video conference between a user and one or more other participants.

In conjunction with RF circuitry **108**, display system **112**, display controller **156**, contact module **130**, graphics module **132**, and text input module **134**, the e-mail client module **140** may be used to create, send, receive, and manage e-mail. In conjunction with image management module **144**, the e-mail module **140** makes it very easy to create and send e-mails with still or video images taken with camera module **143**.

In conjunction with RF circuitry **108**, display system **112**, display controller **156**, contact module **130**, graphics module **132**, and text input module **134**, the instant messaging module **141** may be used to enter a sequence of characters corresponding to an instant message, to modify previously entered characters, to transmit a respective instant message (for example, using a Short Message Service (SMS) or Multimedia Message Service (MMS) protocol), to receive instant messages and to view received instant messages. In some embodiments, transmitted and/or received instant messages may include graphics, photos, audio files, video files and/or other attachments as are supported in a MMS and/or an Enhanced Messaging Service (EMS).

In conjunction with RF circuitry **108**, display system **112**, display controller **156**, contact module **130**, graphics module **132**, text input module **134**, image management module **144**, and browsing module **147**, the blogging module **142** may be used to send text, still images, video, and/or other graphics to a blog (e.g., the user's blog).

In conjunction with display system **112**, display controller **156**, optical sensor(s) **164**, optical sensor controller **158**, contact module **130**, graphics module **132**, and image management module **144**, the camera module **143** may be used to capture still images or video (including a video stream) and store them into memory **102**, modify characteristics of a still image or video, or delete a still image or video from memory **102**.

In conjunction with display system **112**, display controller **156**, contact module **130**, graphics module **132**, text input module **134**, and camera module **143**, the image management module **144** may be used to arrange, modify or otherwise manipulate, label, delete, present (e.g., in a digital slide show or album), and store still and/or video images.

In conjunction with display system **112**, display controller **156**, contact module **130**, graphics module **132**, audio circuitry **110**, and speaker **111**, the video player module **145** may be used to display, present or otherwise play back videos (e.g., on the touch screen or on an external, connected display via external port **124**).

In conjunction with display system **112**, display system controller **156**, contact module **130**, graphics module **132**, audio circuitry **110**, speaker **111**, RF circuitry **108**, and browser module **147**, the music player module **146** allows the user to download and play back recorded music and other sound files stored in one or more file formats, such as MP3 or AAC files. In some embodiments, the device **100** may include the functionality of an MP3 player, such as an iPod (trademark of Apple Computer, Inc.).

In conjunction with RF circuitry **108**, display system **112**, display system controller **156**, contact module **130**, graphics module **132**, and text input module **134**, the browser module **147** may be used to browse the Internet, including searching, linking to, receiving, and displaying web pages or portions thereof, as well as attachments and other files linked to web pages.

In conjunction with RF circuitry **108**, display system **112**, display system controller **156**, contact module **130**, graphics module **132**, text input module **134**, e-mail module **140**, and browser module **147**, the calendar module **148** may be used to create, display, modify, and store calendars and data associated with calendars (e.g., calendar entries, to do lists, etc.).

In conjunction with RF circuitry **108**, display system **112**, display system controller **156**, contact module **130**, graphics module **132**, text input module **134**, and browser module **147**, the widget modules **149** are mini-applications that may be downloaded and used by a user (e.g., weather widget **149-1**, stocks widget **149-2**, calculator widget **149-3**, alarm clock widget **149-4**, and dictionary widget **149-5**) or created by the user (e.g., user-created widget **149-6**). In some embodiments, a widget includes an HTML (Hypertext Markup Language) file, a CSS (Cascading Style Sheets) file, and a JavaScript file. In some embodiments, a widget includes an XML (Extensible Markup Language) file and a JavaScript file (e.g., Yahoo! Widgets).

In conjunction with RF circuitry **108**, display system **112**, display system controller **156**, contact module **130**, graphics module **132**, text input module **134**, and browser module **147**, the widget creator module **150** may be used by a user to create widgets (e.g., turning a user-specified portion of a web page into a widget).

In conjunction with display system **112**, display system controller **156**, contact module **130**, graphics module **132**, and text input module **134**, the search module **151** may be used to search for text, music, sound, image, video, and/or other files in memory **102** that match one or more search criteria (e.g., one or more user-specified search terms).

Each of the above identified modules and applications correspond to a set of instructions for performing one or more functions described above. These modules (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, memory **102** may store a subset of the modules and data structures identified above. Furthermore, memory **102** may store additional modules and data structures not described above.

In some embodiments, the device **100** is a device where operation of a predefined set of functions on the device is performed exclusively through a touch screen in the display system **112** and/or a touchpad. By using a touch screen and/or a touchpad as the primary input/control device for operation of the device **100**, the number of physical input/control devices (such as push buttons, dials, and the like) on the device **100** may be reduced.

The predefined set of functions that may be performed exclusively through a touch screen and/or a touchpad includes navigation between user interfaces. In some embodiments, the touchpad, when touched by the user, navigates the device **100** to a main, home, or root menu from any user interface that may be displayed on the device **100**. In such embodiments, the touchpad may be referred to as a "menu button." In some other embodiments, the menu button may be a physical push button or other physical input/control device instead of a touchpad.

FIG. **2** illustrates a portable multifunction device **100** having a touch screen **112** in accordance with some embodiments. The touch screen may display one or more graphics. In this embodiment, as well as others described below, a user may select one or more of the graphics by making contact or touching the graphics, for example, with one or more fingers **202** (not drawn to scale in the figure). In some embodiments, selection of one or more graphics occurs when the user breaks contact with the one or more graphics. In some embodiments, the contact may include a gesture, such as one or more taps, one or more swipes (from left to right, right to left, upward and/or downward) and/or a rolling of a finger (from right to left, left to right, upward and/or downward) that has made contact with the device **100**. In some embodiments, inadvertent contact with a graphic may not select the graphic. For example, a swipe gesture that sweeps over an application icon may not select the corresponding application when the gesture corresponding to selection is a tap.

The device **100** may also include one or more physical buttons, such as "home" or menu button **204**. As described previously, the menu button **204** may be used to navigate to any application **136** in a set of applications that may be executed on the device **100**. Alternatively, in some embodiments, the menu button is implemented as a soft key in a GUI in touch screen **112**.

In one embodiment, the device **100** includes a touch screen **112**, a menu button **204**, a push button **206** for powering the device on/off and locking the device, and volume adjustment button(s) **208**. The push button **206** may be used to turn the power on/off on the device by depressing the button and holding the button in the depressed state for a predefined time interval; to lock the device by depressing the button and releasing the button before the predefined time interval has elapsed; and/or to unlock the device or initiate an unlock process. In an alternative embodiment, the device **100** also may accept verbal input for activation or deactivation of some functions through the microphone **113**.

Attention is now directed towards embodiments of user interfaces ("UI") and associated processes that may be imple-

mented on a portable multifunction device **100** and/or on a device **1700** with a touch-screen display (FIG. **17**).

FIG. **3** illustrates an exemplary user interface for unlocking a portable electronic device in accordance with some embodiments. In some embodiments, user interface **300** includes the following elements, or a subset or superset thereof:

- Unlock image **302** that is moved with a finger gesture to unlock the device;
- Arrow **304** that provides a visual cue to the unlock gesture;
- Channel **306** that provides additional cues to the unlock gesture;
- Time **308**;
- Day **310**;
- Date **312**; and
- Wallpaper image **314**.

In some embodiments, the device detects contact with the touch-sensitive display (e.g., a user's finger making contact on or near the unlock image **302**) while the device is in a user-interface lock state. The device moves the unlock image **302** in accordance with the contact. The device transitions to a user-interface unlock state if the detected contact corresponds to a predefined gesture, such as moving the unlock image across channel **306**. Conversely, the device maintains the user-interface lock state if the detected contact does not correspond to the predefined gesture. As noted above, processes that use gestures on the touch screen to unlock the device are described in U.S. patent application Ser. No. 11/322,549, "Unlocking a Device by Performing Gestures on an Unlock Image," filed Dec. 23, 2005, which is hereby incorporated by reference herein in its entirety.

FIG. **4** illustrates an exemplary user interface for a menu of applications on a portable multifunction device in accordance with some embodiments. In some embodiments, user interface **400** includes the following elements, or a subset or superset thereof:

- Signal strength indicator **402** for wireless communication;
- Time **404**;
- Battery status indicator **406**;
- Tray **408** with icons for frequently used applications, such as one or more of the following:
  - Phone **138**;
  - E-mail client **140**, which may include an indicator **410** of the number of unread e-mails;
  - Browser **147**; and
  - Music player **146**; and
- Icons for other applications, such as one or more of the following:
  - IM **141**;
  - Image management **144**;
  - Camera **143**;
  - Video player **145**;
  - Weather **149-1**;
  - Stocks **149-2**;
  - Blog **142**;
  - Calendar **148**;
  - Calculator **149-3**;
  - Alarm clock **149-4**;
  - Dictionary **149-5**; and
  - User-created widget **149-6**.

In some embodiments, UI **400** displays all of the available applications **136** on one screen so that there is no need to scroll through a list of applications (e.g., via a scroll bar or via a swipe gesture). In some embodiments, as the number of applications increases, the icons corresponding to the applications may decrease in size so that all applications may be displayed on a single screen without scrolling. In some embodiments, having all applications on one screen and a menu button enables a user to access any desired application with at most two inputs, such as activating the menu button **204** and then activating the desired application (e.g., by a tap or other finger gesture on the icon corresponding to the application).

In some embodiments, UI **400** provides integrated access to both widget-based applications and non-widget-based applications. In some embodiments, all of the widgets, whether user-created or not, are displayed in UI **400**. In other embodiments, activating the icon for user-created widget **149-6** may lead to another UI (not shown) that contains the user-created widgets or icons corresponding to the user-created widgets.

In some embodiments, a user may rearrange the icons in UI **400**, e.g., using processes described in U.S. patent application Ser. No. 11/459,602, "Portable Electronic Device With Interface Reconfiguration Mode," filed Jul. 24, 2006, which is hereby incorporated by reference herein in its entirety. For example, a user may move application icons in and out of tray **408** using finger gestures.

In some embodiments, UI **400** includes a gauge (not shown) that displays an updated account usage metric for an account associated with usage of the device (e.g., a cellular phone account), as described in U.S. patent application Ser. No. 11/322,552, "Account Information Display For Portable Communication Device," filed Dec. 23, 2005, which is hereby incorporated by reference herein in its entirety.

As discussed above, UI **400** may display all of the available applications **136** on one screen so that there is no need to scroll through a list of applications. However, in some embodiments a touch-sensitive display may include a GUI with one or more windows that display only a portion of a list of items (e.g., information items) or of an electronic document. In response to detecting a movement of an object on or near the touch-sensitive display, the list may be scrolled or the electronic document may be translated. Detecting the movement of the object may include determining speed (magnitude), velocity (magnitude and direction), and/or an acceleration (including magnitude and/or direction) of the object. Scrolling through the list or translating the document may be accelerated in response to an accelerated movement of the object. In some embodiments, the scrolling and acceleration of the scrolling, or translation and acceleration of the translation, may be in accordance with a simulation of a physical device having friction, i.e., damped motion. For example, the scrolling or translation may correspond to a simulation of a force law or equation of motion having a mass or inertial term, as well as a dissipative term. In some embodiments, the simulation may correspond to a cylinder rotating about its axis.

In some embodiments, accelerated movement of the detected object may include an accelerated movement of a point of contact followed by a breaking of the point of contact. For example, the user may make contact with the touch-sensitive display, swipe or sweep one or more of his or her fingers along the display (i.e., move and/or accelerate the point of contact), and optionally, break the point of contact with the display, i.e., move the one or more fingers away from the display. The swipe or sweep may be along a predefined axis of the touch-sensitive display or may be within a predetermined angle of a predefined direction on the touch-sensitive display. In other embodiments, the accelerated movement of the point of contact may include a first user gesture oriented along a predefined axis of the touch-sensitive display or oriented within a predetermined angle of a predefined direction on the touch-sensitive display.

Scrolling through the list of items or translating the electronic document may be further accelerated in response to detection of a second movement of an object on or near the touch-sensitive display, such as a second sweeping motion of the point of contact along the predefined axis or within the predetermined angle of a predefined direction on the touch-sensitive display and/or a second user gesture oriented along the predefined axis or within the predetermined angle of a predefined direction on the touch-sensitive display. For example, the user may swipe one or more of his or her fingers along the touch-sensitive display two or more times.

The scrolling through the list of items or the translation of the electronic document may be stopped in accordance with the user breaking the point of contact and then establishing a substantially stationary point of contact with the touch-sensitive display for at least a pre-determined period of time. For example, after swiping one or more of his or her fingers along the touch-sensitive display and breaking the point of contact, the user may touch the display and hold the one or more fingers that are touching the display stationary (or approximately stationary) for one or more seconds, or fractions of a second.

The direction of scrolling or translation may be reversed in response to intersecting a virtual boundary corresponding to a terminus of the list or an edge of the electronic document. The scrolling reversal or translation reversal may correspond to a damped motion. For example, during scrolling, a displayed portion of the list of items may appear to bounce off of a boundary of the window in the touch-sensitive display when a beginning or an end of the list of items is reached. Similarly, during translation, a displayed portion of the electronic document may appear to bounce off of a boundary of the window in the touch-sensitive display when an edge of the document is reached. The apparent bounce may correspond to a simulation of a viscous or elastic ball having momentum in a first direction striking an immovable and/or inelastic object, such as a wall. The subsequent motion of the document (the motion of which corresponds to the ball in the aforementioned analogy) may be damped, for example, by including a friction or dissipative term in the simulation. A parameter corresponding to the friction term in the simulation may be adjustable, allowing the document to reach equilibrium in contact with the virtual boundary, or displaced from the virtual boundary.

In some embodiments movement of the point of contact by the user over an index on the touch-sensitive display may be determined. In some embodiments, the index may be displayed in a first region or a first window of the touch-sensitive display while the list of items or information items during the scrolling may be displayed in a second region or a second window of the touch-sensitive display. The displayed index may have a sequence of index items. In an exemplary embodiment, the sequence of index items may include letters in the alphabet, i.e., the index may include an alphabetical index. The list of information items may include an alphabetically ordered list of information items. The alphabetically ordered list of information items may include contact information, for example, in a user's contact list or address book.

In response to movement of the user's point of contact over a displayed index, the list of information items on the touch-sensitive display may be scrolled. The list of information items may include a sequence of information item subsets corresponding to the sequence of index items. The subsets may include one or more categories. For example, a respective category may include contact information for one or more individuals whose first and/or last names begin with one or more respective letters, such as the letter 's'. In an exemplary embodiment, there is a subset corresponding to each letter in the alphabet that has one or more entries. In some embodiments, the scrolling may be in accordance with a simulation of an equation of motion having friction.

The scrolling may include scrolling through a respective information item subset if the point of contact moves over a corresponding respective index item in the index items. The scrolling may have an associated scroll speed based on a speed of movement of the point of contact over the respective index item and the number of items in the information item subset corresponding to the respective index item. For example, the scroll speed may be faster for subsets that have more entries than subsets with fewer entries. The scrolling may include scrolling through all items in a plurality of the information item subsets in response to the point of contact moving over the corresponding index items in the displayed index.

If it is determined that the point of contact with the index corresponds to a respective index item in the index, the list of information items may be scrolled to a corresponding subset of the list of information items. For example, if the user selects an index item, such as the letter 'R', in the set of index symbols, the list of items may be smoothly scrolled to the corresponding subset for the letter 'R' in the list of items. Alternatively, the displayed list of information items jump directly from a current scroll position to a scroll position in which information items corresponding to the index item 'R' are displayed.

In the present document, the term "if" may be construed to mean "when," or "upon," or "in response to determining," or "in response to detecting," depending on the context Similarly, the phrase "if it is determined" or "if [a stated condition or event] is detected" may be construed to mean "upon determining" or "in response to determining" or "upon detecting" the stated condition or event, or "in response to detecting" the stated condition or event, depending on the context.

If the point of contact with the touch-sensitive display corresponds to a user selection of a respective information item in the list of information items, information corresponding to the respective information item may be displayed on the touch-sensitive display. For example, if the user selects a respective name, the corresponding contact information may be displayed.

While scrolling through respective information subsets, an index symbol may displayed in conjunction with each respective information item subset. In some embodiments, respective index symbols may be displayed adjacent to corresponding subsets (such as displayed text) of the list of information items. In some embodiments, a respective index symbol may be displayed at an upper edge of a window containing the displayed text of the respective information item subset.

The index symbol corresponding to a respective information subset may be translucently displayed over the respective information item subset. The translucently displayed index symbol may have a different font color than that used to display text in the information item subset, and/or it may be displayed using a larger font than the font used to display text in the information item subset.

If the list of information items contains no items for a particular index symbol, i.e., no entries for a particular subset, a first index symbol preceding a particular index symbol and a second index symbol following the index symbol may be displayed in conjunction with scrolling through the list of information items from the information subset corresponding to the first index symbol to the information subset corresponding to the second index symbol. The particular index symbol may not be displayed in conjunction with the displayed text of the list of information items during the scroll

through. For example, display of a respective index symbol may be skipped when the list of information items contains no items for the particular index symbol.

In some embodiments, the list scrolling described here operates without displaying a scroll bar. Similarly, in some embodiments, the translation of electronic documents described here operates without displaying scroll bars. The user's sweeping motion on the touch-sensitive display operation may be performed directly on top of the displayed list or displayed electronic document, and may include a sweeping or gliding motion, near or in contact with the display's surface, along a path anywhere within a display window in which the list or electronic document is displayed. While a scroll bar could potentially be displayed in conjunction with the displayed list, the scrolling or translation described here can be independent of any such scroll bar. In some embodiments, if a scroll bar is used, then an upward movement of a point of contact on the scroll bar may cause earlier entries in the list to be displayed, whereas a downward movement of the point of contact on the scroll bar may cause later entries in the list to be displayed.

In some embodiments, scrolling or translation may be in accordance with a speed of movement of a detected object, such as a speed of movement of a point of contact. The speed may be a time average of values determined during several time intervals. In an exemplary embodiment, the speed, velocity and/or acceleration may be determined over five time intervals, where a respective time interval corresponds to an inverse of a frame rate, such as 0.0167 s, of a display. In some embodiments, the speed, velocity and/or acceleration may be determined even when a variable frame rate is used, such as when one or more frames are skipped or not displayed. In these embodiments, the speed, velocity, and/or acceleration may be determined two or more times for the respective time interval and/or may be projected based on values determined in a preceding and/or a subsequent time interval.

In some embodiments, the scrolling or translation after a user optionally breaks the contact may be in accordance with the change in the acceleration and the speed or the velocity in one or more time intervals prior to the breaking of the contact. For example, the velocity v_f of scrolling or translation one or more time intervals after breaking contact may be determined using

$$v_f = v_o + \alpha\Delta t,$$

where v_o is a current value of the velocity when the contact is broken, a is a current value of the acceleration when the contact is broken and Δt is an elapsed time, such as one time interval. The velocities and/or acceleration in such a calculation may be projected along an axis or direction of the scrolling or translation. In some embodiments, in subsequent time intervals following the determination of the velocity based on the acceleration and/or the velocity in one or more time intervals prior to the breaking of the contact, the velocity of the scrolling or translation may be tapered. For example, in each successive time interval the velocity may be decreased by 5%. When the velocity crosses a lower threshold, it may be set to zero.

FIG. **5** is a flow diagram illustrating a method **500** of scrolling through a list in accordance with some embodiments. The method **500** provides a simple visual indicator to a user that a terminus of a list has been reached.

Movement of an object is detected on or near a touch screen display of a device (**502**). In some embodiments, the object is a finger. In some embodiments, the device is a portable multifunction device.

In response to detecting the movement, a list of items displayed on the touch screen display is scrolled in a first direction (**504**). In some embodiments, the list is a list of email messages, as illustrated in FIGS. **6**A-**6**D. In some embodiments, the list of items is a list of instant message conversations, a list of favorite phone numbers, a list of contact information (sometimes called a contact list or address book list), a list of labels, a list of email folders, a list of email addresses, a list of physical addresses, a list of ringtones, a list of album names, or a list of bookmarks. In some embodiments, the first direction is a vertical direction; in some other embodiments, the first direction is a horizontal direction. In some embodiments, scrolling the list in the first direction prior to reaching a terminus of the list has an associated scrolling speed corresponding to a speed of movement of the object (**506**). In some embodiments, the list is scrolled in accordance with a simulation of an equation of motion having friction (**508**).

If a terminus of the list is reached (e.g., upon reaching the terminus of the list) while scrolling the list in the first direction while the object is still detected on or near the touch screen display, an area beyond the terminus of the list is displayed (**510**-Yes, **514**). In some embodiments, the list has a first item and a last item and the terminus is either the first item or the last item. For example, in FIG. **6**B the email **3534** from Aaron Jones is the first item and thus the terminus of the corresponding list of emails. In some embodiments, the area beyond the terminus of the list is white (**516**). In some embodiments, the list of items has a background and the area beyond the terminus of the list is visually indistinct from the background (**518**). For example, in FIG. **6**C both the area **3536** and the background of the listed emails are white.

After the object is no longer detected on or near the touch screen display, the list of items is scrolled in a second direction opposite the first direction until the area beyond the terminus of the list is no longer displayed (**520**). In some embodiments, the list is scrolled in the second direction using a damped motion (**522**). In some embodiments, the change from scrolling the list in the first direction to scrolling the list in the second direction until the area beyond the terminus of the list is no longer displayed makes the terminus of the list appear to be elastically attached to an edge of the touch screen display or to an edge displayed on the touch screen display (**524**).

In some embodiments, scrolling in the first direction prior to reaching the terminus of the list has a first associated scrolling distance that corresponds to a distance of movement of the object prior to reaching the terminus of the list. For example, a scrolling distance prior to reaching the terminus of the list shown in FIGS. **6**A-**6**D may correspond to a distance traversed on the touch screen display by the swipe gesture **3514** before the terminus is reached. Displaying an area beyond the terminus of the list includes scrolling the list in the first direction for a second associated scrolling distance that is less than a distance of movement of the object after the terminus is reached. For example, in FIG. **6**C, after the terminus is reached the list is scrolled for a distance **3538**, which may be less than a distance traversed on the touch screen display by the swipe gesture **3514** after the terminus is reached.

In some embodiments, scrolling in the first direction prior to reaching a terminus of the list has a first associated scrolling speed that corresponds to a speed of movement of the object. For example, a scrolling speed prior to reaching the terminus of the list shown in FIGS. **6**A-**6**D may correspond to a speed on the touch screen display of the swipe gesture **3514** before the terminus is reached. Displaying an area beyond the

terminus of the list includes scrolling the list in the first direction at a second associated scrolling speed. The second associated scrolling speed is slower than the first associated scrolling speed. For example, in FIG. **6**C, displaying the area **3536** beyond the terminus of the list may include scrolling the list at a speed that is slower than the scrolling speed before the terminus is reached. In some embodiments, the second associated speed is a fraction (e.g., one-half or one-third) of the first associated speed. In some embodiments, the second associated speed is the square root of the first associated speed.

If a terminus of the list is not reached while scrolling the list in the first direction while the object is still detected on or near the touch screen display, the process **500** is complete (**510**-No, **512**). The process **500** may be re-initiated upon subsequent detection of another movement of an object on or near the touch screen display (**502**).

FIGS. **6**A-**6**D illustrate the scrolling of a list of items to a terminus of the list, at which point an area beyond the terminus is displayed and the list is then scrolled in an opposite direction until the area beyond the terminus is no longer displayed, in accordance with some embodiments. While FIGS. **6**A-**6**D illustrate this scrolling in the context of a portable multifunction device **100**, this scrolling is not limited to portable multifunction devices. In the example of FIGS. **6**A-**6**D, the listed items are email messages; FIGS. **6**A-**6**D illustrate an exemplary user interface **3500**A for managing an inbox in accordance with some embodiments. An analogous user interface may be used to display and manage other mailboxes (e.g., drafts, sent, trash, personal, etc.). In addition, other types of lists are possible, including but not limited to lists of instant message conversations, favorite phone numbers, contact information, labels, email folders, email addresses, physical addresses, ringtones, album names or bookmarks.

In some embodiments, user interface **3500**A include the following elements, or a subset or superset thereof:

- **402**, **404**, and **406**, as described above;
- a create email icon **3310** that when activated (e.g., by a finger tap on the icon) initiates display of a UI to create a new email message;
- mailboxes icon **3502** that when activated (e.g., by a finger tap on the icon) initiates the display of a UI listing email mailboxes (i.e., folders);
- unread messages icon **3504** that displays the number of unread messages in the inbox;
- names **3506** of the senders of the email messages;
- subject lines **3508** for the email messages;
- dates **3510** of the email messages;
- unread message icons **3512** that indicate messages that have not been opened;
- preview pane separator **3518** that separates the list of messages from a preview of a selected message in the list;
- settings icon **3520** that when activated (e.g., by a finger tap on the icon) initiates the display of a UI to modify settings;
- move message icon **3522** that when activated (e.g., by a finger tap on the icon) initiates the display of a UI to move messages;
- Delete symbol icon **3524** that when activated (e.g., by a finger tap on the icon) initiates display of a UI to confirm that the user wants to delete the selected email;
- Reply/Forward icon **3526** that when activated (e.g., by a finger tap on the icon) initiates display of a UI to select how to reply or forward the selected email;

If the list of emails fills more than the allotted screen area, the user may scroll through the emails using vertically upward and/or vertically downward swipe gestures on the touch screen. In the example of FIG. **6**A, a portion of a list of emails is displayed in the screen area, including a top displayed email **3530** from Bruce Walker and a bottom displayed email **3532** from Kim Brook. A user performs a vertically downward swipe gesture **3514** to scroll toward the top of the list. The vertically downward gesture **3514**, which may be a finger gesture, corresponds to the movement of an object on or near the touch screen that is detected in operation **502** of process **500** (FIG. **5**). The vertically downward gesture **3514** need not be exactly vertical; a substantially vertical gesture is sufficient. In some embodiments, a gesture within a predetermined angle of being perfectly vertical results in vertical scrolling. In one embodiment, a gesture within 27 degrees of being perfectly vertical results in vertical scrolling.

As a result of detecting the vertically downward gesture **3514**, in FIG. **6**B the displayed emails have shifted down, such that the previous bottom displayed email **3532** from Kim Brook is no longer displayed, the previous top displayed email **3530** from Bruce Walker is now second from the top, and the email **3534** from Aaron Jones, which was not displayed in FIG. **6**A, is now displayed at the top of the list. This shifting of emails is an example of the scrolling described in operation **504** of process **500** (FIG. **5**).

In this example, the email **3534** from Aaron Jones is the first email in the list and thus is the terminus of the list. Upon reaching this email **3534**, in response to continued detection of the vertically downward gesture **3514**, an area **3536** (FIG. **6**C) above the first email **3534** (i.e., beyond the terminus of the list) is displayed, as described in operation **514** of process **500** (FIG. **5**). In some embodiments, the area displayed beyond the terminus of the list is visually indistinct from the background of the list, as described in operation **518** of process **500** (FIG. **5**). In FIG. **6**C, both the area **3536** and the background of the emails (e.g., emails **3534** and **3530**) are white and thus are visually indistinct.

Once vertically downward gesture **3514** is complete, such that a corresponding object is no longer detected on or near the touch screen display, the list is scrolled in an opposite direction until the area **3536** is no longer displayed. FIG. **6**D illustrates the result of this scrolling in the opposite direction, which corresponds to operation **520** of process **500** (FIG. **5**): the email **3534** from Aaron Jones is now displayed at the top of the screen area allotted to the list and the area **3536** is not displayed.

In the example of FIGS. **6**A-**6**D, a vertically downward gesture resulted in display of an area beyond the first item in the list. Similarly, a vertically upward gesture may result in display of an area beyond the last item of the list, if the vertically upward gesture continues once the list has been scrolled to the last item. The last item may be considered a terminus of the list, similar to the first item. As discussed above, the gesture need not be exactly vertical to result in vertical scrolling; a gesture within a predefined range of angles from perfectly vertical is sufficient.

In some embodiments, instead of scrolling a list of items in one dimension, a user may desire to translate an electronic document in two dimensions. If the electronic document fills more than the screen area allotted to display the document, the screen will only display a portion of the document. The user may translate the electronic document to view portions of the document that are not initially displayed.

FIG. **7** is a flow diagram illustrating a method **700** of translating an electronic document in accordance with some embodiments. The method **700** provides a simple visual indicator to a user that one or more edges of an electronic document are being displayed.

Movement of an object is detected on or near a touch screen display of a device (**702**). In some embodiments, the object is a finger. In some embodiments, the device is a portable multifunction device.

In response to detecting the movement, an electronic document displayed on the touch screen display is translated in a first direction (**704**). In some embodiments, the electronic document is a web page, as illustrated in FIGS. **8**A-**8**D. In some embodiments, the electronic document is a digital image. In some embodiments, the electronic document is a word processing, spreadsheet, email, or presentation document. In some embodiments, the first direction is a vertical direction, a horizontal direction, or a diagonal direction. In some embodiments, the first direction corresponds to the direction of movement of the object detected on or near the display but is not necessarily identical to the direction of movement of the object.

In some embodiments, translating the electronic document in the first direction prior to reaching an edge of the electronic document has an associated speed of translation corresponding to a speed of movement of the object (**706**). In some embodiments, the electronic document is translated in accordance with a simulation of an equation of motion having friction (**708**).

If an edge of the electronic document is reached (e.g., upon reaching the edge of the document) while translating the electronic document in the first direction while the object is still detected on or near the touch screen display, an area beyond the edge of the electronic document is displayed (**710**-Yes, **714**). In some embodiments, the area beyond the edge of the electronic document is black, gray, a solid color, or white (**716**). In some embodiments, the area beyond the edge of the electronic document is visually distinct from the document (**718**). For example, the area **3930** beyond the edge of the web page **3912** in FIG. **8**C is black, in contrast to the white background of the web page **3912**. In some other embodiments, a wallpaper image such as a picture or pattern may be displayed in the area beyond the edge of the electronic document.

After the object is no longer detected on or near the touch screen display, the electronic document is translated in a second direction until the area beyond the edge of the electronic document is no longer displayed (**720**). For example, in FIG. **8**D the web page **3912** has been translated such that the area **3930** beyond its edge is no longer displayed. In some embodiments, the second direction is opposite the first direction. In some embodiments, the electronic document is translated in the second direction using a damped motion (**722**). In some embodiments, the change from translating the electronic document in the first direction to translating the electronic document in the second direction until the area beyond the edge of the electronic document is no longer displayed makes the edge of the electronic document appear to be elastically attached to an edge of the touch screen display or to an edge displayed on the touch screen display (**724**).

In some embodiments, translating in the first direction prior to reaching an edge of the electronic document has a first associated translating distance that corresponds to a distance of movement of the object prior to reaching the edge of the electronic document. For example, a distance of translation of the web page **3912** shown in FIGS. **8**A-**8**D prior to reaching the edge of the document may correspond to a distance traversed on the touch screen display by the swipe gesture **3925** before the edge is reached. In some embodiments, displaying an area beyond the edge of the electronic document includes translating the electronic document in the first direction for a second associated translating distance, wherein the second associated translating distance is less than a distance of movement of the object after reaching the edge of the electronic document. For example, in FIG. **8**C, after the edge is reached the web page **3912** is translated by a distance indicated by opposing arrows 3928-1 and 3928-2, which may be less than a distance traversed on the touch screen display by the swipe gesture **3925** after the terminus is reached.

In some embodiments, translating in the first direction prior to reaching an edge of the electronic document has a first associated translating speed that corresponds to a speed of movement of the object. For example, a speed of translation prior to reaching the edge of the web page **3912** shown in FIGS. **8**A-**8**D may correspond to a speed of movement of the swipe gesture **3925**. Displaying an area beyond the edge of the electronic document includes translating the electronic document in the first direction at a second associated translating speed. The second associated translating speed is slower than the first associated translating speed. For example, in FIG. **8**C, displaying the area **3930** beyond the edge of the web page **3912** may include translating the web page **3912** at a speed that is slower than the speed of translation before the edge is reached. In some embodiments, the second associated speed is a fraction (e.g., one-half or one-third) of the first associated speed. In some embodiments, the second associated speed is the square root of the first associated speed.

If an edge of the electronic document is not reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display, the process **700** is complete (**710**-No, **712**). The process **700** may be re-initiated upon subsequent detection of another movement of an object on or near the touch screen display (**702**).

FIGS. **8**A-**8**D illustrate the translation of an electronic document to an edge of the document, at which point an area beyond the edge is displayed and the document is then translated in a second direction until the area beyond the edge of the document is no longer displayed, in accordance with some embodiments. While FIGS. **8**A-**8**D illustrate this translation in the context of a portable multifunction device **100**, this translation is not limited to portable multifunction devices. In the example of FIGS. **8**A-**8**D, the document is a web page **3912**; FIGS. **8**A-**8**D illustrate an exemplary user interface for a browser in accordance with some embodiments. An analogous user interface may be used to display other types of electronic documents, such as word processing, spreadsheet, email, presentation documents, or digital images.

In some embodiments, user interface **3900**A of FIGS. **8**A-**8**D includes the following elements, or a subset or superset thereof:

- **402**, **404**, and **406**, as described above;
- Previous page icon **3902** that when activated (e.g., by a finger tap on the icon) initiates display of the previous web page;
- Web page name **3904**;
- Next page icon **3906** that when activated (e.g., by a finger tap on the icon) initiates display of the next web page;
- URL (Uniform Resource Locator) entry box **3908** for inputting URLs of web pages;
- Refresh icon **3910** that when activated (e.g., by a finger tap on the icon) initiates a refresh of the web page;
- Web page **3912** or other structured document, which is made of blocks **3914** of text content and other graphics (e.g., images);
- Settings icon **3916** that when activated (e.g., by a finger tap on the icon) initiates display of a settings menu for the browser;

Bookmarks icon **3918** that when activated (e.g., by a finger tap on the icon) initiates display of a bookmarks list or menu for the browser;

Add bookmark icon **3920** that when activated (e.g., by a finger tap on the icon) initiates display of a UI for adding bookmarks; and

New window icon **3922** that when activated (e.g., by a finger tap on the icon) initiates display of a UI for adding new windows to the browser.

In some embodiments, the device analyzes the render tree of the web page **3912** to determine the blocks **3914** in the web page. In some embodiments, a block **3914** corresponds to a render node that is: replaced; a block; an inline block; or an inline table.

In FIG. **8**A, the web page fills more than the allotted screen area: only the left sides of block **7** (**3914-7**) and block **8** (**3914-8**) are displayed and only the top left corner of block **9** (**3914-9**) is displayed. To view the partially displayed blocks, a user may translate the displayed document by gesturing on the touch screen in accordance with some embodiments.

In some embodiments, in response to a substantially vertical upward (or downward) swipe gesture by the user, the web page (or, more generally, other electronic documents) may translate one-dimensionally upward (or downward) in the vertical direction. In some embodiments, a gesture is considered substantially vertical if it is within a predetermined angle of being perfectly vertical. For example, in response to an upward swipe gesture by the user that is within a predetermined angle (e.g., 27°) of being perfectly vertical, the web page may scroll one-dimensionally upward in the vertical direction.

Conversely, in some embodiments, in response to a gesture that is not within a predetermined angle (e.g., 27°) of being perfectly vertical, the web page may translate two-dimensionally (i.e., with simultaneous movement in both the vertical and horizontal directions). For example, in response to an upward swipe gesture by the user that is not within a predetermined angle (e.g., 27°) of being perfectly vertical, the web page may translate two-dimensionally along the direction of the swipe.

In the example of FIG. **8**A, an upward swipe gesture **3925** is not within a predetermined angle of being perfectly vertical. Therefore, as a result of detecting the upward swipe gesture **3925**, the web page is translated in two dimensions. In this example, the translation is approximately diagonal. FIG. **8**B illustrates the result of this translation: blocks **8** (**3914-8**) and **9** (**3914-9**) are now fully displayed; blocks **1** (**3914-1**) and **2** (**3914-2**) are now only partially displayed, and block **3** (**3914-3**) is no longer displayed at all. This translation is an example of the translation described in operation **704** of process **700** (FIG. **7**).

In FIG. **8**B, block **9** (**3914-9**) is in the lower right-hand corner of the web page **3912**; both the bottom and right edges of the web page have been reached while translating the web page. Upon reaching these edges of the document, in response to continued detection of the upward gesture **3925**, an area **3930** (FIG. **8**C) beyond the bottom and right edges of the web page is displayed. In some embodiments, the area displayed beyond the edge(s) of an electronic document is visually distinct from the document, as described in operation **718** of process **700** (FIG. **7**). In FIG. **8**C, the area **3930** is black and thus is visually distinct from the white background of the web page **3912**.

Once the upward gesture **3925** is complete, such that a corresponding object is no longer detected on or near the touch screen display, the web page **3912** is translated (e.g., in a direction opposite to the original direction of translation) until the area **3930** is no longer displayed. FIG. **8**D illustrates the result of this translation, which corresponds to operation **720** of process **700** (FIG. **7**): block **9** (**3914-9**) is now displayed in the lower right-hand corner of the portion of the screen allotted to display the web page **3912** and the area **3930** not displayed. In some embodiments, the direction of translation is not necessarily opposite to the original direction but may be in any direction such that, upon completion of the translation, the area beyond the edge(s) of the electronic document is no longer displayed.

FIG. **9** is a flow diagram illustrating a process **900** of displaying an electronic document having a document length and a document width, in accordance with some embodiments. The process **900** provides a simple visual indicator to a user that an electronic document is being displayed at a minimum magnification (e.g., the electronic document cannot be zoomed out and/or demagnified further).

The process **900** is performed at a device with a touch screen display. In some embodiments, the device is a portable multifunction device. In some embodiments, the electronic document is a web page (e.g., web page **3912**, FIGS. **10**A-**10**C). In some embodiments, the electronic document is a digital image. In some embodiments, the electronic document is a word processing, spreadsheet, email or presentation document.

The electronic document is displayed (**902**) at a first magnification on the touch screen display. A gesture is detected (**904**) on or near the touch screen display corresponding to a command to zoom out by a user-specified amount. In some embodiments, the gesture is a pinching gesture (e.g., gesture **3951**/**3953**, FIG. **10**A).

In response to detecting the gesture, the electronic document is displayed (**906**) at a magnification less than the first magnification. For example, the web page **3912** is shown at a lesser magnification in FIG. **10**B than in FIG. **10**A.

If the document length or document width is not entirely displayed (**908**-No) while the gesture is still detected on or near the touch screen display, the process **900** is complete (**910**).

If, however, the document length (e.g., **3957**, FIG. **10**B) or document width (e.g., **3959**, FIG. **10**B) is entirely displayed (**908**-Yes) while the gesture (e.g., **3951**/**3953**) is still detected on or near the touch screen display, the electronic document is displayed (**912**) at a magnification wherein areas beyond opposite edges of the electronic document (e.g., areas **3955**, FIG. **10**B) are displayed.

In some embodiments, the areas beyond opposite edges of the electronic document include an area beyond a top edge of the document and an area beyond a bottom edge of the document. In some embodiments, the areas beyond opposite edges of the electronic document include an area beyond a right edge of the document and an area beyond a left edge of the document. In some embodiments, the areas beyond opposite edges of the electronic document include an area beyond a top edge of the document, an area beyond a bottom edge of the document, an area beyond a right edge of the document, and an area beyond a left edge of the document (e.g., FIG. **10**B).

In some embodiments, the areas beyond opposite edges of the electronic document are black, gray, a solid color, or white. In some embodiments, the areas beyond opposite edges of the electronic document are visually distinct from the document. For example, the areas **3955** (FIG. **10**B) are black and thus are visually distinct from the web page **3912**.

Upon detecting termination of the gesture, the electronic document is displayed (**914**) at a magnification wherein the

areas beyond opposite edges of the electronic document are no longer displayed. For example, the areas **3955** are not displayed in FIG. **10**C.

FIGS. **10**A-**10**C illustrate the display of an electronic document at multiple magnifications in accordance with some embodiments. While FIGS. **10**A-**10**C illustrate displaying these multiple magnifications in the context of a portable multifunction device **100**, displaying these multiple magnifications is not limited to portable multifunction devices. In the example of FIGS. **10**A-**10**C, the document is a web page **3912**; FIGS. **10**A-**10**C (like FIGS. **8**A-**8**D) illustrate an exemplary user interface for a browser in accordance with some embodiments. An analogous user interface may be used to display other types of electronic documents, such as digital images or word processing, spreadsheet, email, or presentation documents.

In FIG. **10**A, the web page **3912** is displayed at a first magnification. The web page **3912** fills more than the allotted screen area: only the left sides of block **7** (**3914-7**) and block **8** (**3914-8**) are displayed and only the top left corner of block **9** (**3914-9**) is displayed.

In response to detecting a pinching gesture **3951**/**3953** (FIG. **10**A), the web-page is displayed at a magnification less than the first magnification, as shown in FIG. **10**B. If a document length **3957** or a document width **3959** is entirely displayed while the gesture **3951**/**3953** is still detected, areas **3955** beyond opposite edges of the web page **3912** are displayed. Upon detecting termination of the gesture **3951**/**3953**, the web page **3912** is displayed at a magnification wherein the areas **3955** are no longer displayed, as shown in FIG. **10**C.

FIG. **11** is a flow diagram illustrating a process **1100** of displaying an electronic document at multiple magnifications in accordance with some embodiments. The process **1100** provides a simple visual indicator to a user that an electronic document is being displayed at a maximum magnification (e.g., the electronic document cannot be zoomed in and/or magnified further).

The process **1100** is performed at a device with a touch screen display. In some embodiments, the device is a portable multifunction device. In some embodiments, the electronic document is a web page (e.g., web page **3912**, FIGS. **12**A-**12**C). In some embodiments, the electronic document is a digital image (e.g., digital image **1302**, FIGS. **13**A-**13**C). In some embodiments, the electronic document is a word processing, spreadsheet, email or presentation document.

At least a first portion of the electronic document is displayed (**1102**) at a first magnification. A gesture is detected (**1104**) on or near the touch screen display corresponding to a command to zoom in by a user-specified amount. In some embodiments, the gesture is a de-pinching gesture (e.g., **3931**/**3933**, FIGS. **12**A and **13**A).

In response to detecting the gesture, decreasing portions of the electronic document are displayed (**1106**) at increasing magnifications. For example, in FIG. **12**B a decreased portion of the web page **3912** is displayed at a higher magnification than the portion in FIG. **12**A, and in FIG. **13**B a decreased portion of the digital image **1302** is displayed at a higher magnification than the portion in FIG. **13**A.

If, upon detecting termination of the gesture, the magnification does not exceed a predefined magnification (**1108**-No), the process **1100** is complete (**1110**).

If, however, upon detecting termination of the gesture, the magnification exceeds a predefined magnification (**1108**-Yes), a respective portion of the electronic document is displayed (**1112**) at the predefined magnification. In the examples of FIGS. **12**B and **13**B, the magnification exceeds a predefined magnification. Upon detecting termination of the gesture **3931**/**3933**, a portion of the web page **3912** is displayed at the predefined magnification, as illustrated in FIG. **12**C, and a portion of the digital image **1302** is displayed at the predefined magnification, as illustrated in FIG. **13**C.

In some embodiments, immediately prior to detecting termination of the gesture, a last decreased portion of the electronic document is displayed at a first resolution. Upon detecting termination of the gesture, the respective portion of the electronic document is displayed at a second resolution that is greater than the first resolution.

FIGS. **12**A-**12**C illustrate the display of an electronic document at multiple magnifications in accordance with some embodiments. While FIGS. **12**A-**12**C illustrate displaying these multiple magnifications in the context of a portable multifunction device **100**, displaying these multiple magnifications is not limited to portable multifunction devices. In the example of FIGS. **12**A-**12**C, the document is a web page **3912**; FIGS. **12**A-**12**C (like FIGS. **8**A-**8**D) illustrate an exemplary user interface for a browser in accordance with some embodiments. An analogous user interface may be used to display other types of electronic documents, such as digital images or word processing, spreadsheet, email, or presentation documents.

In FIG. **12**A, a first portion of the web page **3912** is displayed at a first magnification. The web page **3912** fills more than the allotted screen area: only the left sides of block **7** (**3914-7**) and block **8** (**3914-8**) are displayed and only the top left corner of block **9** (**3914-9**) is displayed.

In response to detecting a de-pinching gesture **3931**/**3933** (FIG. **12**A), decreasing portions of the web-page **3912** are displayed at increasing magnifications compared to the magnification shown in FIG. **12**A. For example, the portion of the web page **3912** shown in FIG. **12**B is smaller than and has a higher magnification than the portion of the web page **3912** shown in FIG. **12**A.

In the example of FIG. **12**B, the magnification exceeds a predefined magnification. Upon detecting termination of the gesture **3931**/**3933**, a portion of the web page **3912** is displayed at the predefined magnification, as illustrated in FIG. **12**C.

FIGS. **13**A-**13**C illustrate the display of an electronic document at multiple magnifications in accordance with some embodiments. While FIGS. **13**A-**13**C illustrate displaying these multiple magnifications in the context of a portable multifunction device **100**, displaying these multiple magnifications is not limited to portable multifunction devices. In the example of FIGS. **13**A-**13**C, the document is a digital image **1302** that includes an image of a person **1304**.

In FIG. **13**A, a digital image **1302** is displayed at a first magnification. In response to detecting a de-pinching gesture **3931**/**3933**, decreasing portions of the digital image **1302** are displayed at increasing magnifications compared to the magnification shown in FIG. **13**A. For example, the portion of the digital image **1302** shown in FIG. **13**B is smaller than and has a higher magnification than the portion of the digital image **1302** shown in FIG. **13**A.

In the example of FIG. **13**B, the magnification exceeds a predefined magnification. Upon detecting termination of the gesture **3931**/**3933**, a portion of the digital image **1302** is displayed at the predefined magnification, as illustrated in FIG. **13**C.

FIG. **14** is a flow diagram illustrating a process **1400** of executing a screen rotation command in accordance with some embodiments. The process **1400** provides a simple visual indicator to a user that the user has not provided a sufficient gesture to initiate a 90° screen rotation command.

The process **1400** is performed at a device with a touch screen display. In some embodiments, the device is a portable multifunction device.

A multifinger twisting gesture (e.g., **1506**, FIG. **15**A, or **1508**, FIG. **15**C) is detected (**1402**) on or near the touch screen display. The multifinger twisting gesture has a corresponding degree of rotation. In some embodiments, the multifinger twisting gesture includes gestures by two thumbs **1604**-L and **1604**-R (FIGS. **16**A and **16**D)

If the corresponding degree of rotation exceeds a predefined degree of rotation (**1404**-Yes), a 90° screen rotation command is executed (**1406**). For example, the digital image **1502** of FIGS. **15**A and **16**A is rotated from a portrait orientation to a landscape orientation, as shown respectively in FIGS. **15**B and **16**B.

If the corresponding degree of rotation does not exceed a predefined degree of rotation (**1404**-No), a screen rotation command with an acute angle of rotation (i.e., less than 90°) is executed (**1408**). For example, the digital image **1502** of FIGS. **15**C and **16**D is rotated by an acute angle, as shown respectively in FIGS. **15**D and **16**E. Upon ceasing to detect the multifinger twisting gesture, a screen rotation command is executed (**1410**) with an angle of rotation opposite to the acute angle (e.g., with the result shown in FIGS. **15**E and **16**F).

FIGS. **15**A-**15**E illustrate rotating the display of an electronic document or other digital object in accordance with some embodiments. While FIGS. **15**A-**15**E illustrate display rotation in the context of a portable multifunction device **100**, display rotation is not limited to portable multifunction devices. In the example of FIGS. **15**A-**15**E, the electronic document is a digital image **1502**.

In FIGS. **15**A and **15**C, the digital image **1502** is displayed in a portrait orientation. A multifinger twisting gesture **1506** (FIG. **15**A) or **1508** (FIG. **15**C) is detected on the touch screen display. The multifinger twisting gesture **1506** or **1508** has a corresponding degree of rotation. In some embodiments, the degree of rotation corresponds to a degree of rotation of an axis between the contact points on the touch screen display of the two fingers in the multifinger gesture (e.g., an axis between the center points or centroids of the contact regions of the two fingers).

In the example of FIG. **15**A, the multifinger twisting gesture **1506** has a corresponding degree of rotation that exceeds a predefined degree of rotation. Thus, a 90° screen rotation command is executed, with the result that the digital image is displayed in a landscape orientation, as shown in FIG. **15**B. In the example of FIG. **15**C, however, the multifinger twisting gesture **1508** has a corresponding degree of rotation that does not exceed a predefined degree of rotation. A screen rotation command with an acute angle of rotation is executed, with the result shown in FIG. **15**D. Upon ceasing to detect the multifinger twisting gesture **1508**, a screen rotation command with an angle opposite to the acute angle is executed, with the result that the portrait orientation of the digital image **1502** is restored, as shown in FIG. **15**E.

FIGS. **16**A-**16**F illustrate an exemplary screen rotation gesture in accordance with some embodiments. While FIGS. **16**A-**16**F illustrate this screen rotation gesture in the context of a portable multifunction device **100**, this screen rotation gesture is not limited to portable multifunction devices. In the example of FIGS. **16**A-**16**F, this screen rotation gesture is used to rotate the digital image **1502**.

In FIG. **16**A, the device **100** displays the digital image **1502** in a portrait orientation. Simultaneous rotation of two thumbs (e.g., **1604**-L and **1604**-R) in a first sense of rotation is detected on the touch screen display **112**. In some embodiments, the first sense of rotation is a clockwise rotation (e.g., FIG. **16**C). The simultaneous rotation of the two thumbs has a corresponding degree of rotation.

In some embodiments, the sense of rotation for each thumb is detected by monitoring the change in orientation of the contact area of the thumb with the touch screen display. For example, if the contact area of the thumb is elliptical, the change in the orientation of an axis of the ellipse may be detected (e.g., from contact ellipse **1606**-L in FIG. **16**A to contact ellipse **1608**-L in FIG. **16**B, as shown on an enlarged portion of touch screen **112** in FIG. **16**C). In some embodiments, the change in the orientation of the axis of the ellipse determines the corresponding degree of rotation. In some embodiments, at least some of a user's other fingers (i.e., fingers other than thumbs **1604**-L and **1604**-R) support the device **100** by contacting the backside of the device.

In some embodiments, the first sense of rotation is a counterclockwise rotation. For example, if thumb **1604**-L is initially on the lower left side of touch screen **112** (rather than the upper left side in FIG. **16**A), thumb **1604**-R is initially on the upper right side of touch screen **112** (rather than the lower right side in FIG. **16**A), and the thumbs are moved apart from each other, then the sense of rotation detected by the touch screen **112** will be counterclockwise for both thumbs.

If the corresponding degree of rotation exceeds a predefined degree of rotation, a 90° screen rotation command is executed. For example, display of the digital image **1502** is rotated from the portrait orientation of FIG. **16**A to a landscape orientation in FIG. **16**B.

If, however, the corresponding degree of rotation does not exceed a predefined degree of rotation, a screen rotation command with an acute angle of rotation is executed. For example, the digital image **1502** in FIG. **16**D is rotated by an acute angle, with the result shown in FIG. **16**E. Once detection of the two thumbs **1604**-L and **1604**-R ceases, a screen rotation command with an angle of rotation opposite to the acute angle is executed, thereby restoring the digital image **1502** to a portrait orientation, as shown in FIG. **16**F.

While FIGS. **6**A-**6**D, **8**A-**8**D, **10**A-**10**C, **12**A-**12**C, **13**A-**13**C, **15**A-**15**E, and **16**A-**16**F illustrate scrolling, translation, scaling, and rotation operations in the context of a portable multifunction device **100**, similar operations may be performed on any device with a touch-screen display, in accordance with some embodiments. The device, such as device **1700** below, may or may not be portable and the function or functions performed by the device may vary.

FIG. **17** is a block diagram illustrating a device **1700** with a touch-screen display in accordance with some embodiments. Device **1700** need not be portable. The device **1700** typically includes one or more processing units (CPU's) **1710**, one or more network or other communications interfaces **1760**, memory **1770**, and one or more communication buses **1720** for interconnecting these components. The communication buses **1720** may include circuitry (sometimes called a chipset) that interconnects and controls communications between system components. The device **1700** includes a user interface **1730** comprising a touch-screen display **1740**. The user interface **1730** also may include a keyboard and/or mouse (or other pointing device) **1750**. Memory **1770** includes high-speed random access memory, such as DRAM, SRAM, DDR RAM or other random access solid state memory devices; and may include non-volatile memory, such as one or more magnetic disk storage devices, optical disk storage devices, flash memory devices, or other non-volatile solid state storage devices. Memory **1770** may optionally include one or more storage devices remotely located from the CPU(s) **1710**. In some embodiments, memory **1770** stores

programs, modules, and data structures analogous to the programs, modules, and data structures stored in the memory **102** of portable multifunction device **100** (FIG. **1**), or a subset thereof. Furthermore, memory **1770** may store additional programs, modules, and data structures (not shown) not present in the memory **102** of portable multifunction device **100**.

Each of the above identified elements in FIG. **17** may be stored in one or more of the previously mentioned memory devices. Each of the above identified modules corresponds to a set of instructions for performing a function described above. The above identified modules or programs (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various embodiments. In some embodiments, memory **1770** may store a subset of the modules and data structures identified above. Furthermore, memory **1770** may store additional modules and data structures not described above.

The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A computer-implemented method, comprising:

at a device with a touch screen display:

displaying a first portion of an electronic document;

detecting a movement of an object on or near the touch screen display;

in response to detecting the movement, translating the electronic document displayed on the touch screen display in a first direction to display a second portion of the electronic document, wherein the second portion is different from the first portion;

in response to an edge of the electronic document being reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display:

displaying an area beyond the edge of the document, and

displaying a third portion of the electronic document, wherein the third portion is smaller than the first portion; and

in response to detecting that the object is no longer on or near the touch screen display, translating the electronic document in a second direction until the area beyond the edge of the electronic document is no longer displayed to display a fourth portion of the electronic document, wherein the fourth portion is different from the first portion.

2. The computer-implemented method of claim **1**, wherein the first portion of the electronic document, the second portion of the electronic document, the third portion of the electronic document, and the fourth portion of the electronic document are displayed at the same magnification.

3. The computer-implemented method of claim **1**, wherein the movement of the object is on the touch screen display.

4. The computer-implemented method of claim **1**, wherein the object is a finger.

5. The computer-implemented method of claim **1**, wherein the first direction is a vertical direction, a horizontal direction, or a diagonal direction.

6. The computer-implemented method of claim **1**, wherein the electronic document is a web page.

7. The computer-implemented method of claim **1**, wherein the electronic document is a digital image.

8. The computer-implemented method of claim **1**, wherein the electronic document is a word processing, spreadsheet, email or presentation document.

9. The computer-implemented method of claim **1**, wherein the electronic document includes a list of items.

10. The computer-implemented method of claim **1**, wherein the second direction is opposite the first direction.

11. The computer-implemented method of claim **1**, wherein translating in the first direction prior to reaching an edge of the document has an associated speed of translation that corresponds to a speed of movement of the object.

12. The computer-implemented method of claim **1**, wherein translating in the first direction is in accordance with a simulation of an equation of motion having friction.

13. The computer-implemented method of claim **1**, wherein the area beyond the edge of the document is black, gray, a solid color, or white.

14. The computer-implemented method of claim **1**, wherein the area beyond the edge of the document is visually distinct from the document.

15. The computer-implemented method of claim **1**, wherein translating the document in the second direction is a damped motion.

16. The computer-implemented method of claim **1**, wherein changing from translating in the first direction to translating in the second direction until the area beyond the edge of the document is no longer displayed makes the edge of the electronic document appear to be elastically attached to an edge of the touch screen display or to an edge displayed on the touch screen display.

17. The computer-implemented method of claim **1**, wherein translating in the first direction prior to reaching the edge of the electronic document has a first associated translating distance that corresponds to a distance of movement of the object prior to reaching the edge of the electronic document; and wherein displaying an area beyond the edge of the electronic document comprises translating the electronic document in the first direction for a second associated translating distance, wherein the second associated translating distance is less than a distance of movement of the object after reaching the edge of the electronic document.

18. The computer-implemented method of claim **1**, wherein translating in the first direction prior to reaching the edge of the electronic document has a first associated translating speed that corresponds to a speed of movement of the object, and wherein displaying an area beyond the edge of the electronic document comprises translating the electronic document in the first direction at a second associated translating speed, wherein the second associated translating speed is slower than the first associated translating speed.

19. A device, comprising:

a touch screen display;

one or more processors;

memory; and

one or more programs, wherein the one or more programs are stored in the memory and configured to be executed by the one or more processors, the programs including:

instructions for displaying a first portion of an electronic document;

instructions for detecting a movement of an object on or near the touch screen display;

instructions for translating the electronic document displayed on the touch screen display in a first direction to display a second portion of the electronic document, wherein the second portion is different from the first portion, in response to detecting the movement;

instructions for displaying an area beyond an edge of the electronic document and displaying a third portion of the electronic document, wherein the third portion is smaller than the first portion, in response to the edge of the electronic document being reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display; and

instructions for translating the electronic document in a second direction until the area beyond the edge of the electronic document is no longer displayed to display a fourth portion of the electronic document, wherein the fourth portion is different from the first portion, in response to detecting that the object is no longer on or near the touch screen display.

20. A computer readable storage medium having stored therein instructions, which when executed by a device with a touch screen display, cause the device to:

display a first portion of an electronic document;

detect a movement of an object on or near the touch screen display;

translate the electronic document displayed on the touch screen display in a first direction to display a second portion of the electronic document, wherein the second portion is different from the first portion, in response to detecting the movement

display an area beyond an edge of the electronic document and display a third portion of the electronic document, wherein the third portion is smaller than the first portion, if the edge of the electronic document is reached while translating the electronic document in the first direction while the object is still detected on or near the touch screen display; and

translate the electronic document in a second direction until the area beyond the edge of the electronic document is no longer displayed to display a fourth portion of the electronic document, wherein the fourth portion is different from the first portion, in response to detecting that the object is no longer on or near the touch screen display.

* * * * *

EXHIBIT E

US005920726A

United States Patent [19]

Anderson

[11] Patent Number: 5,920,726

[45] Date of Patent: Jul. 6, 1999

[54] **SYSTEM AND METHOD FOR MANAGING POWER CONDITIONS WITHIN A DIGITAL CAMERA DEVICE**

[75] Inventor: **Eric C. Anderson**, San Jose, Calif.

[73] Assignee: **Apple Computer, Inc.**, Cupertino, Calif.

[21] Appl. No.: **08/873,412**

[22] Filed: **Jun. 12, 1997**

[51] **Int. Cl.**[6] **G06F 1/30**

[52] **U.S. Cl.** **395/750.01**

[58] **Field of Search** 395/750.01, 750.02, 395/750.03, 750.04, 750.05, 750.06, 182.22, 182.2, 182.12, 737, 575

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,283,792	2/1994	Davies, Jr. et al.	371/66
5,359,728	10/1994	Rusmack et al.	395/575
5,386,552	1/1995	Garney	395/575
5,475,428	12/1995	Hintz et al.	348/263
5,475,441	12/1995	Parulski et al.	348/552
5,477,264	12/1995	Sarbadhikari et al.	348/231
5,493,335	2/1996	Parulski et al.	348/233
5,560,022	9/1996	Dunstan et al.	395/750.01
5,634,000	5/1997	Wicht	395/182.08

OTHER PUBLICATIONS

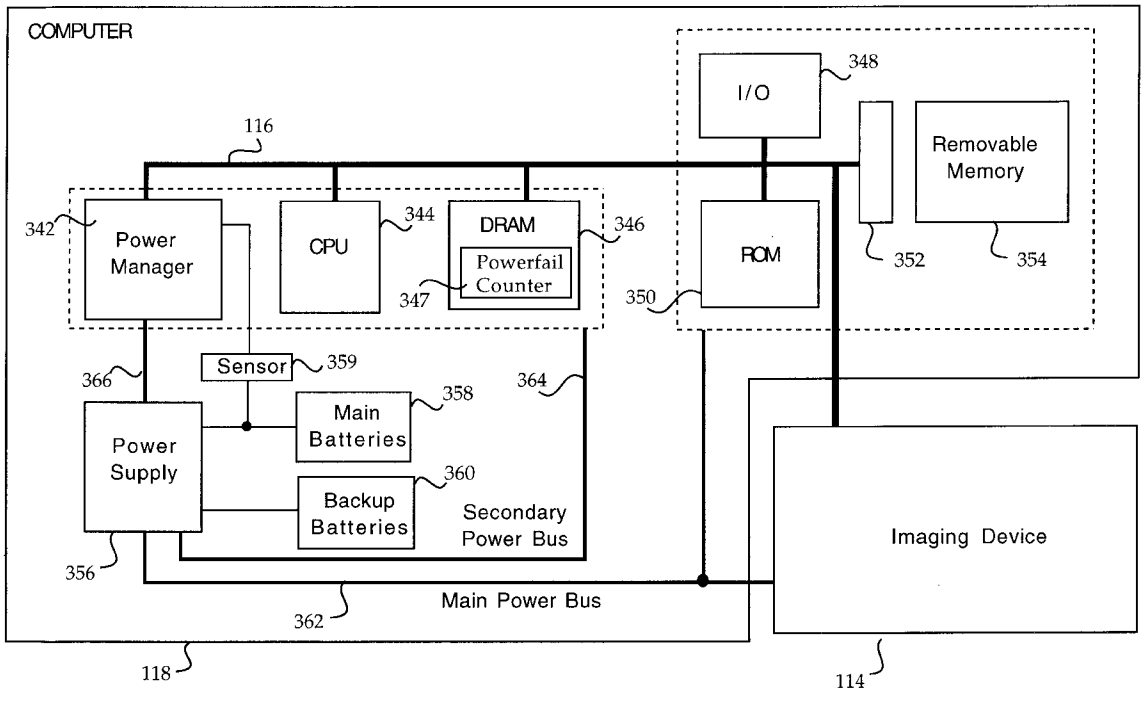
Martyn Williams, Review–NEC PC–DC401 Digital Still Camera, AppleLink Newbytes, Mar. 15, 1996, pp. 1–3.

Primary Examiner—Ayaz R. Sheikh
Assistant Examiner—Xuan M. Thai
Attorney, Agent, or Firm—Carr & Ferrell LLP; Gregory J. Koerner

[57] **ABSTRACT**

A system and method for recovering from a power failure in a digital camera comprises a power manager for detecting and handling power failures, an interrupt handler for responsively incrementing a counter device, service routines which register to receive notification of the power failure, and a processor for evaluating the counter and providing notification of the power failure to the service routines which may then assist the digital camera to recover from the power failure.

18 Claims, 11 Drawing Sheets



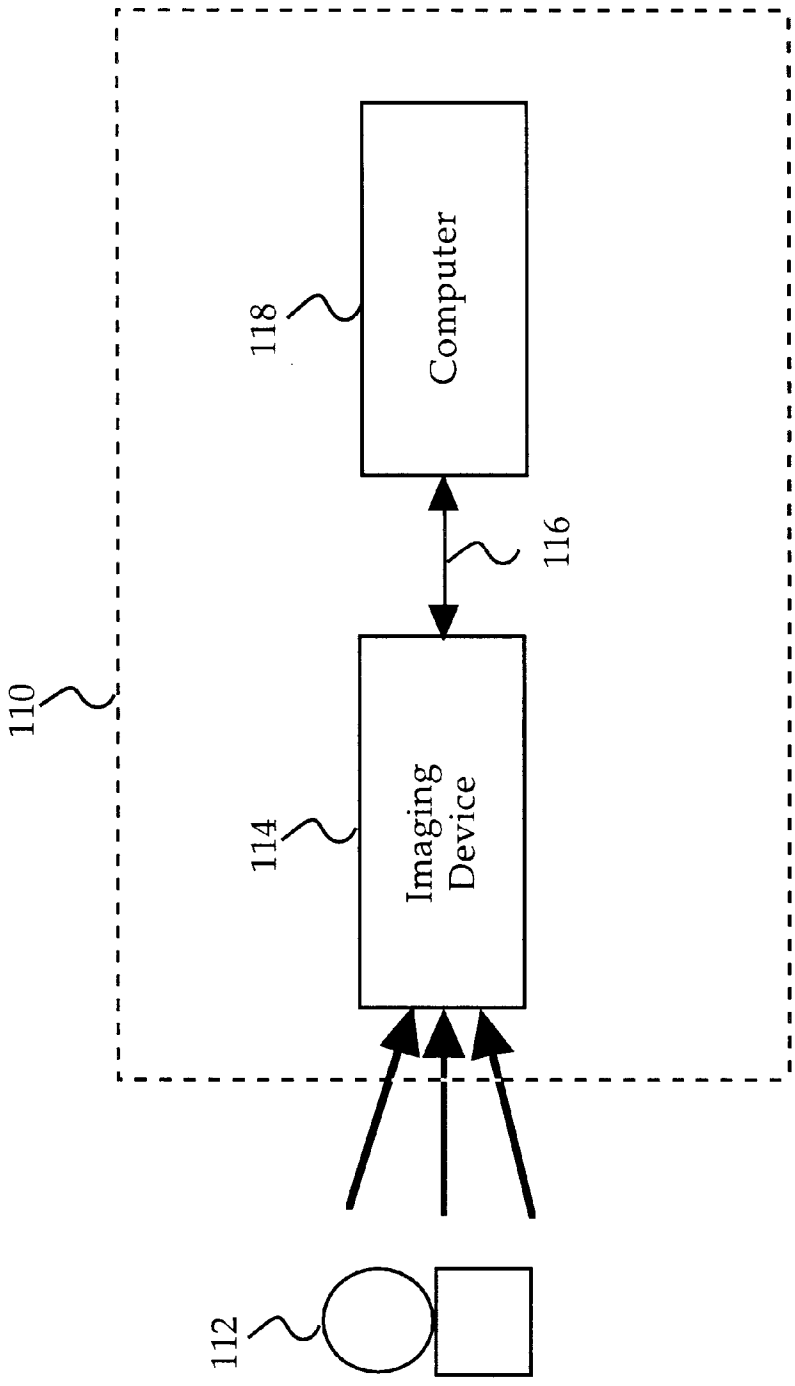


FIG. 1

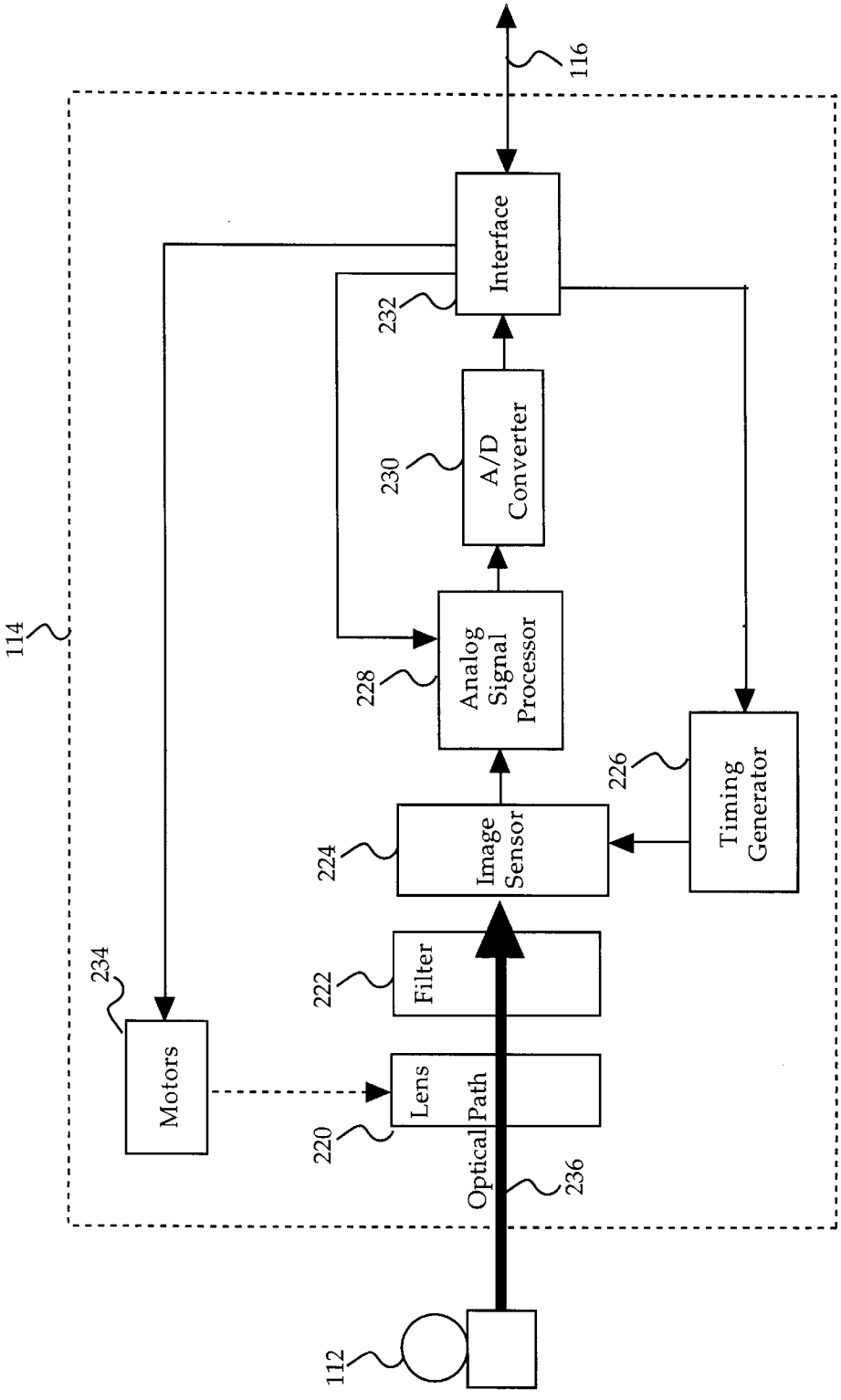

116
Interface
232
A/D Converter
230
Analog Signal Processor
228
Timing Generator
226
Image Sensor
224
Filter
222
Lens
220
Optical Path
236
Motors
234
114
112

FIG. 2

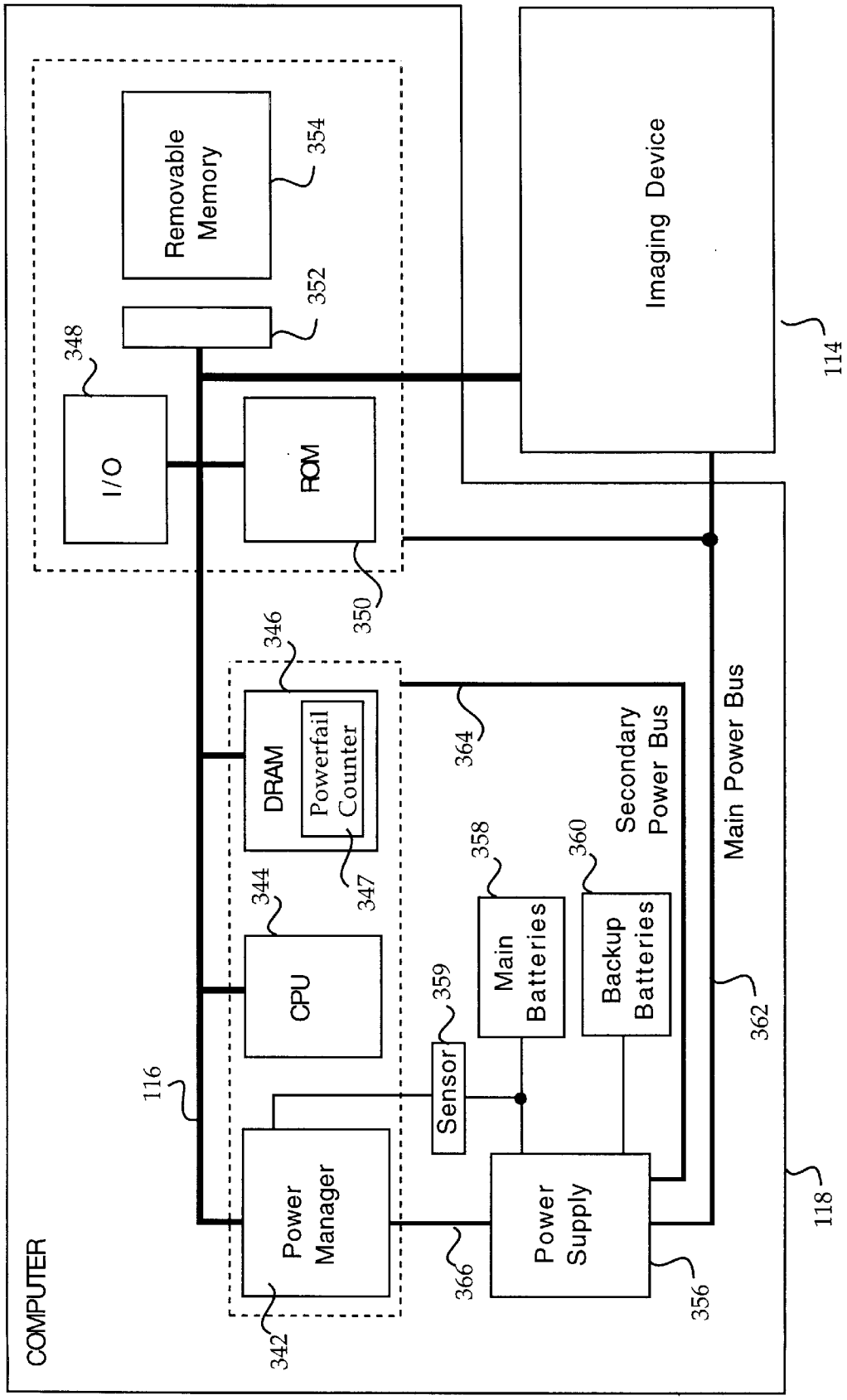

COMPUTER
Removable Memory
354
352
348
I/O
ROM
350
Imaging Device
114
346
DRAM
Powerfail Counter
347
344
CPU
116
Power Manager
342
Sensor
359
Main Batteries
358
Backup Batteries
360
Secondary Power Bus
364
Main Power Bus
362
Power Supply
366
356
118

FIG. 3

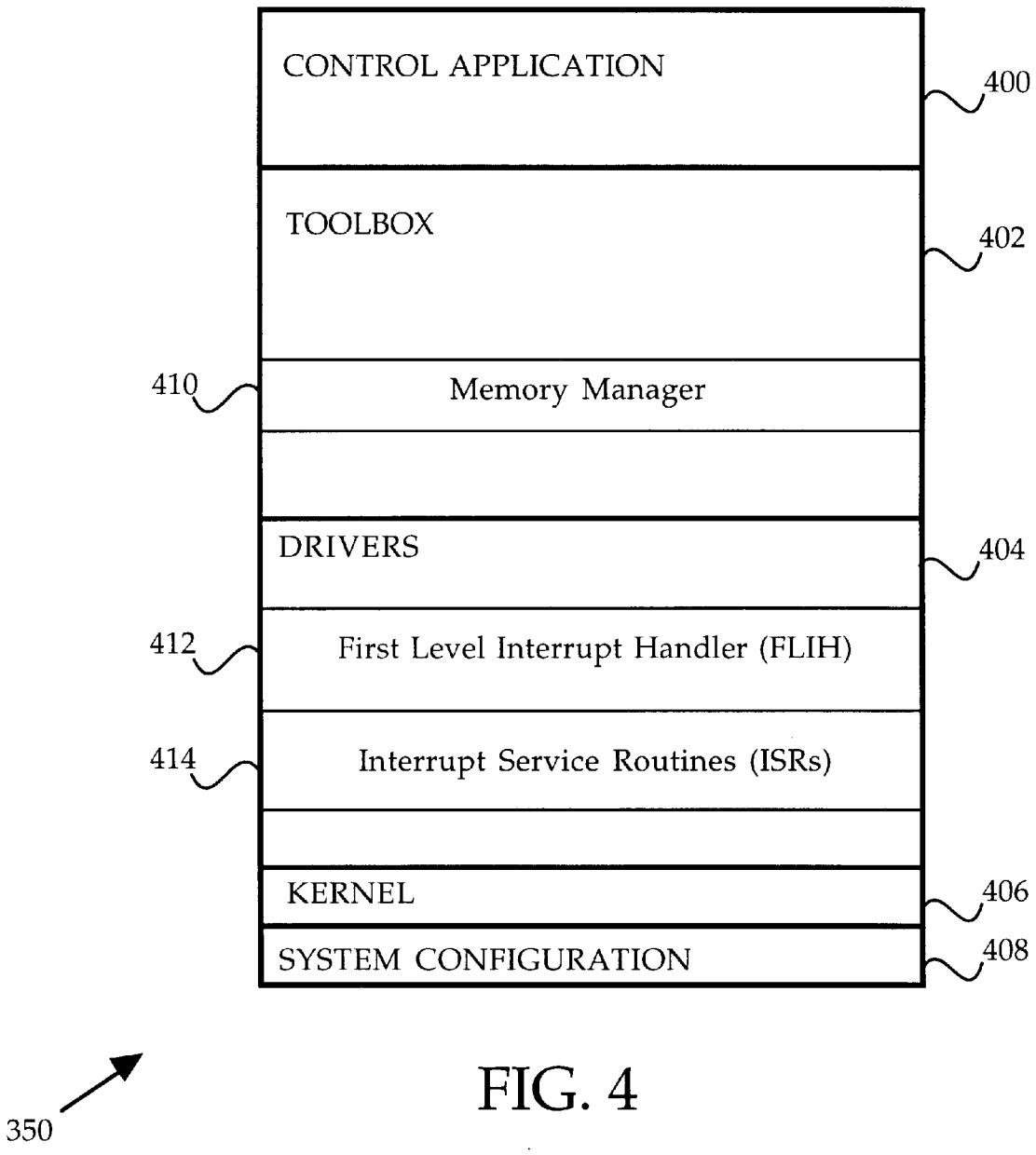

CONTROL APPLICATION
400
TOOLBOX
402
410
Memory Manager
DRIVERS
404
412
First Level Interrupt Handler (FLIH)
414
Interrupt Service Routines (ISRs)
KERNEL
406
SYSTEM CONFIGURATION
408
350

FIG. 4

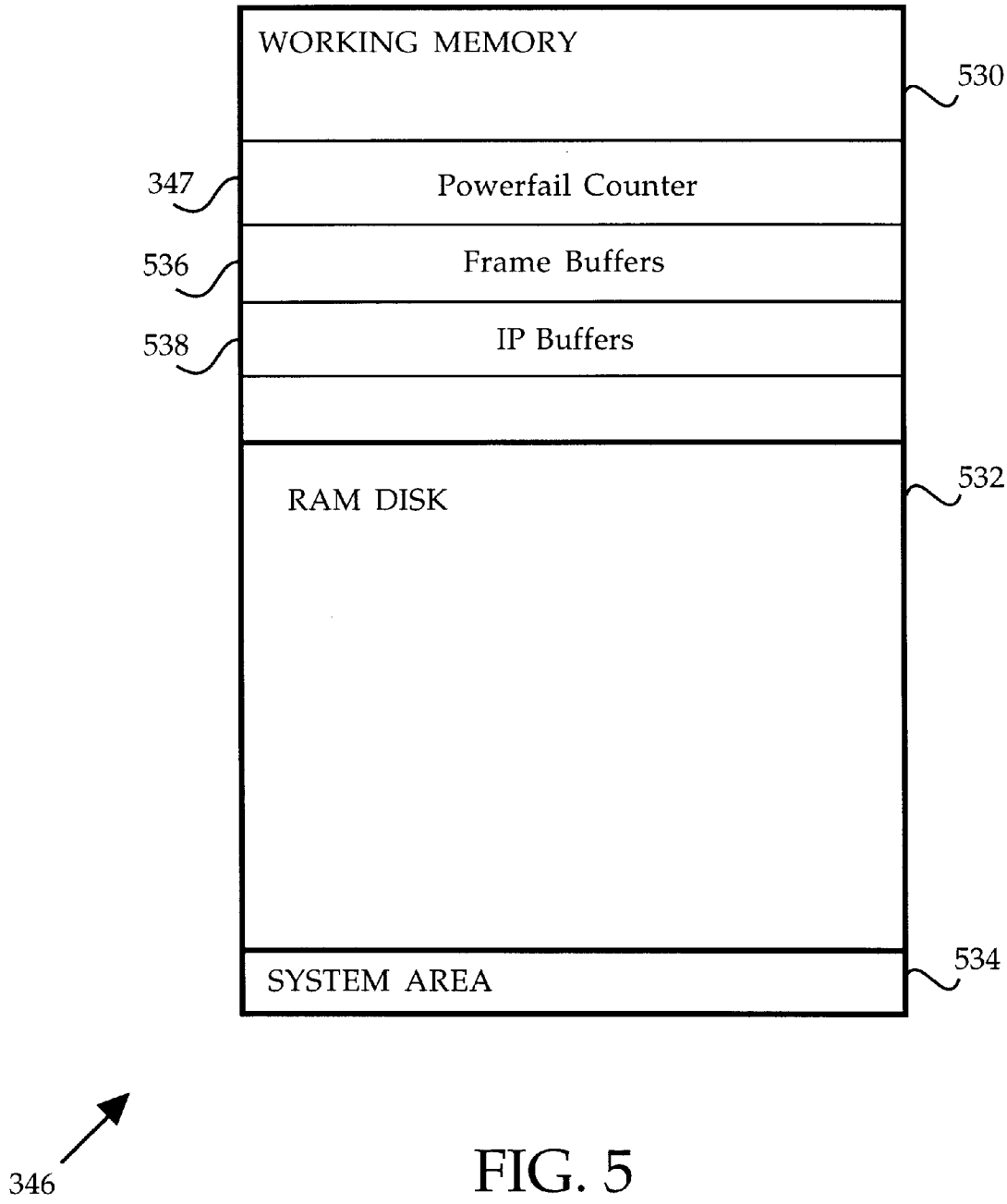

WORKING MEMORY
530
347
Powerfail Counter
536
Frame Buffers
538
IP Buffers
RAM DISK
532
SYSTEM AREA
534
346

FIG. 5

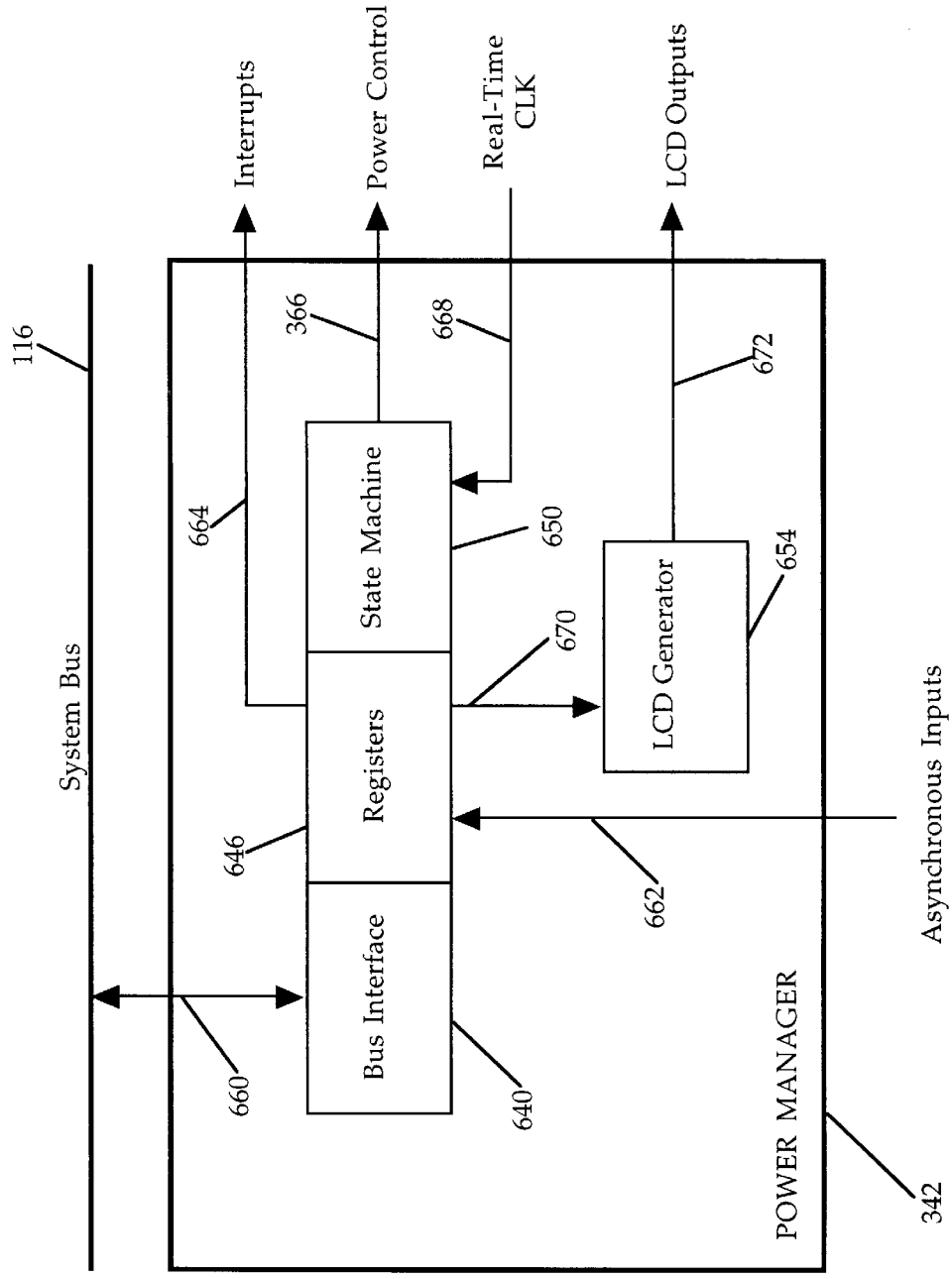

Interrupts
Power Control
Real-Time CLK
LCD Outputs
116
366
668
672
664
650
654
670
646
662
660
640
342
System Bus
State Machine
Registers
Bus Interface
LCD Generator
Asynchronous Inputs
POWER MANAGER

FIG. 6

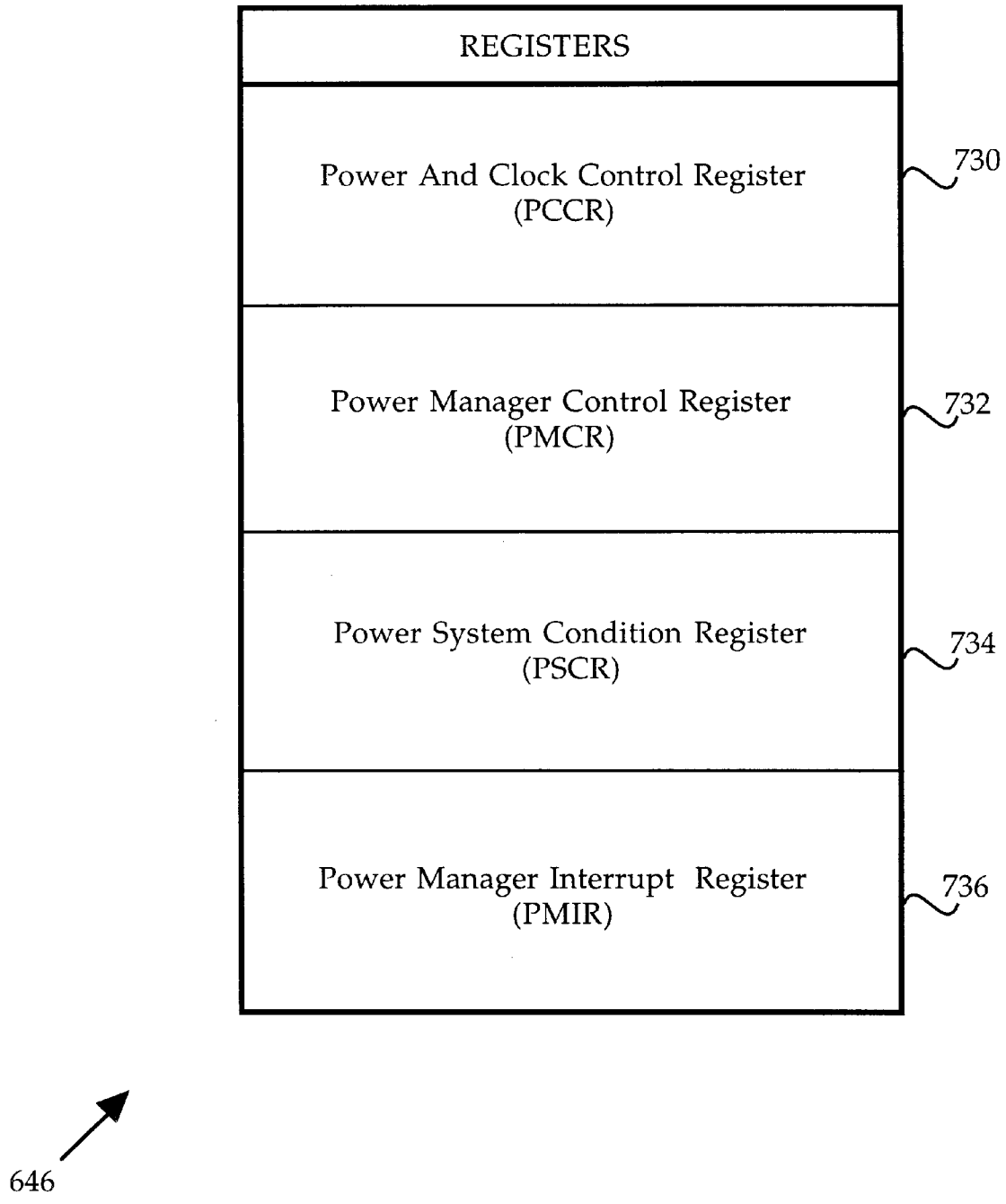

REGISTERS
Power And Clock Control Register (PCCR)
730
Power Manager Control Register (PMCR)
732
Power System Condition Register (PSCR)
734
Power Manager Interrupt Register (PMIR)
736
646

FIG. 7

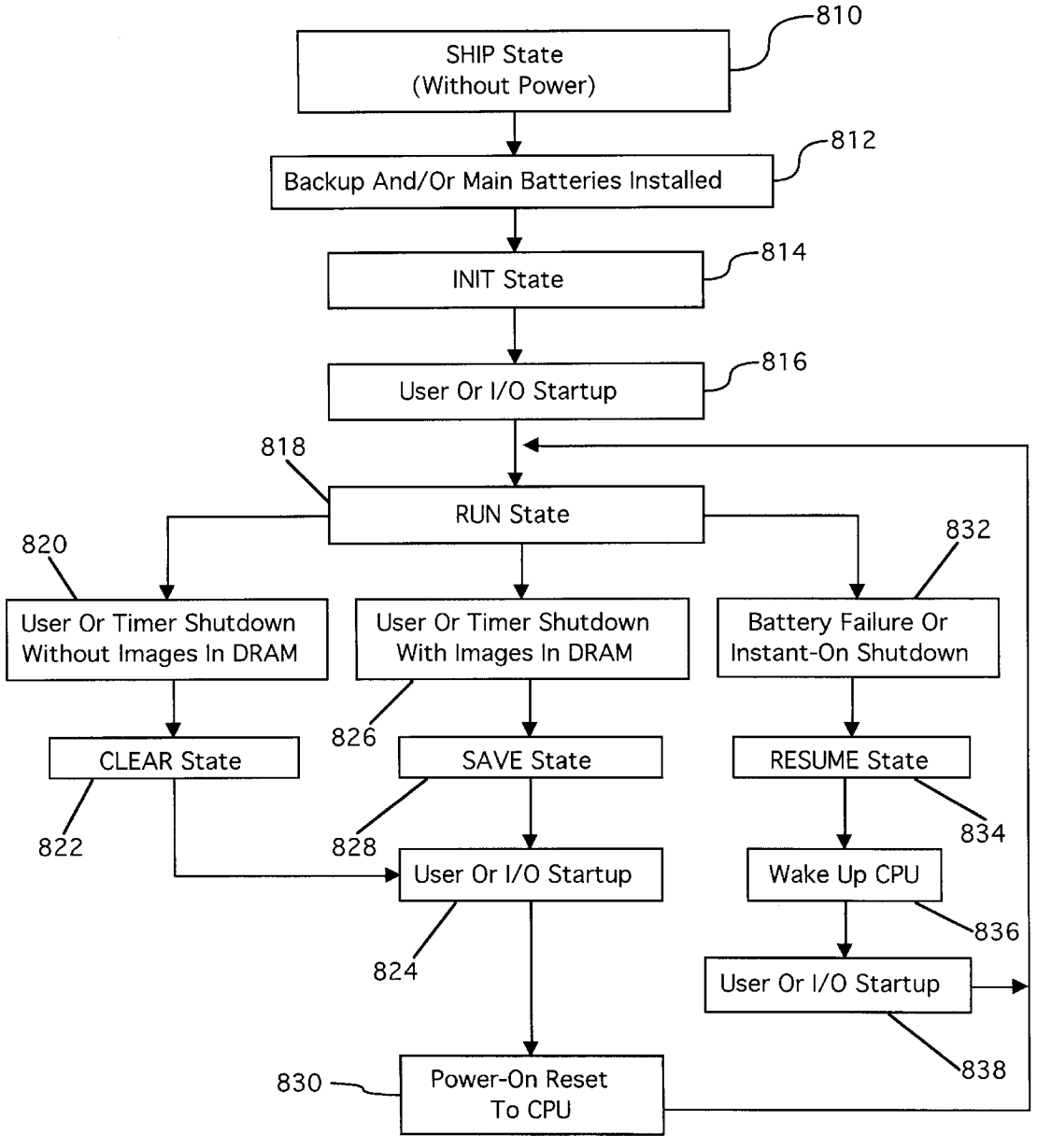

810
SHIP State
(Without Power)
812
Backup And/Or Main Batteries Installed
814
INIT State
816
User Or I/O Startup
818
RUN State
820
User Or Timer Shutdown
Without Images In DRAM
User Or Timer Shutdown
With Images In DRAM
826
832
Battery Failure Or
Instant-On Shutdown
CLEAR State
822
SAVE State
828
RESUME State
834
User Or I/O Startup
824
Wake Up CPU
836
User Or I/O Startup
838
830
Power-On Reset
To CPU

FIG. 8

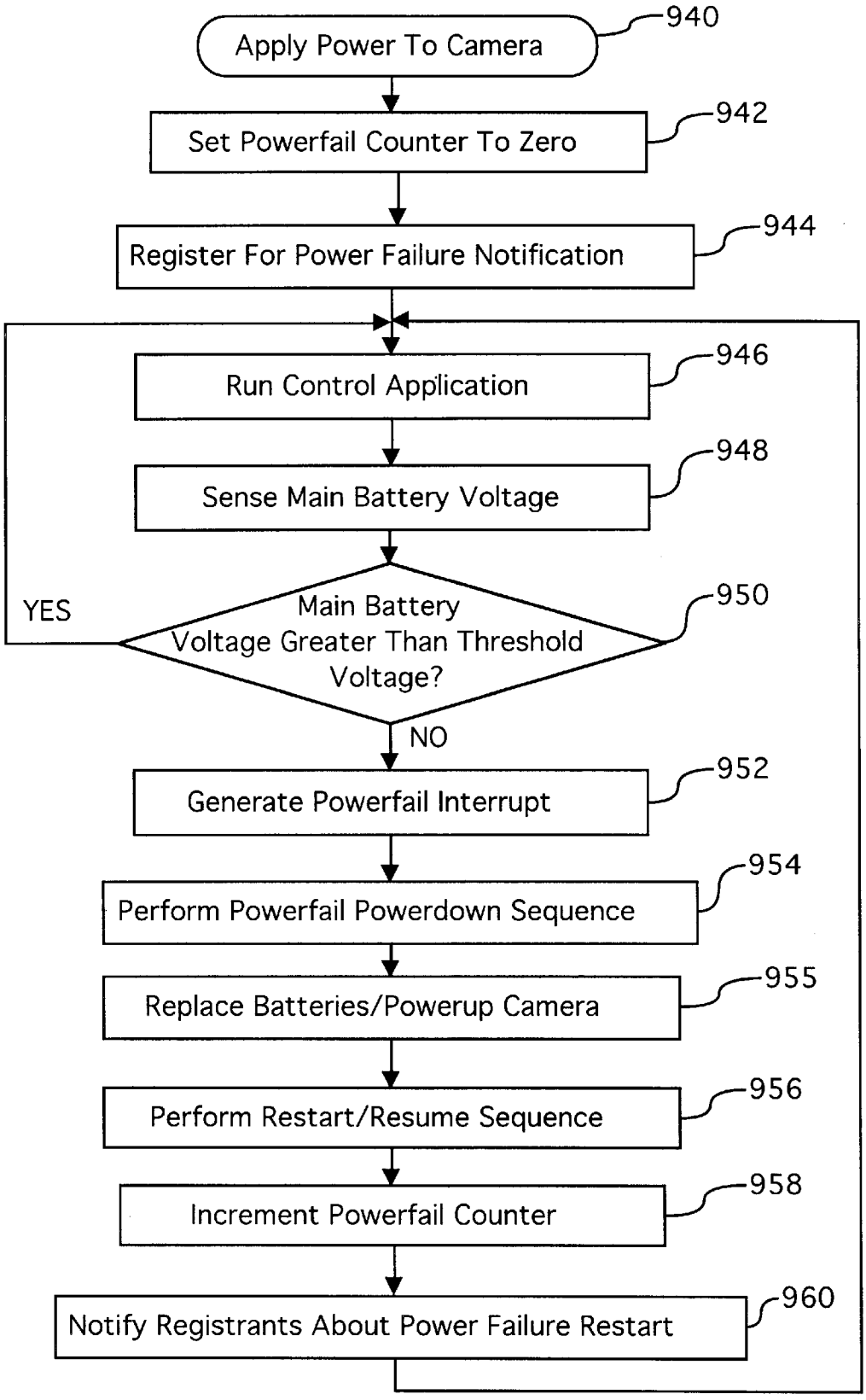

Apply Power To Camera
940
Set Powerfail Counter To Zero
942
Register For Power Failure Notification
944
Run Control Application
946
Sense Main Battery Voltage
948
Main Battery Voltage Greater Than Threshold Voltage?
950
YES
NO
Generate Powerfail Interrupt
952
Perform Powerfail Powerdown Sequence
954
Replace Batteries/Powerup Camera
955
Perform Restart/Resume Sequence
956
Increment Powerfail Counter
958
Notify Registrants About Power Failure Restart
960

FIG. 9

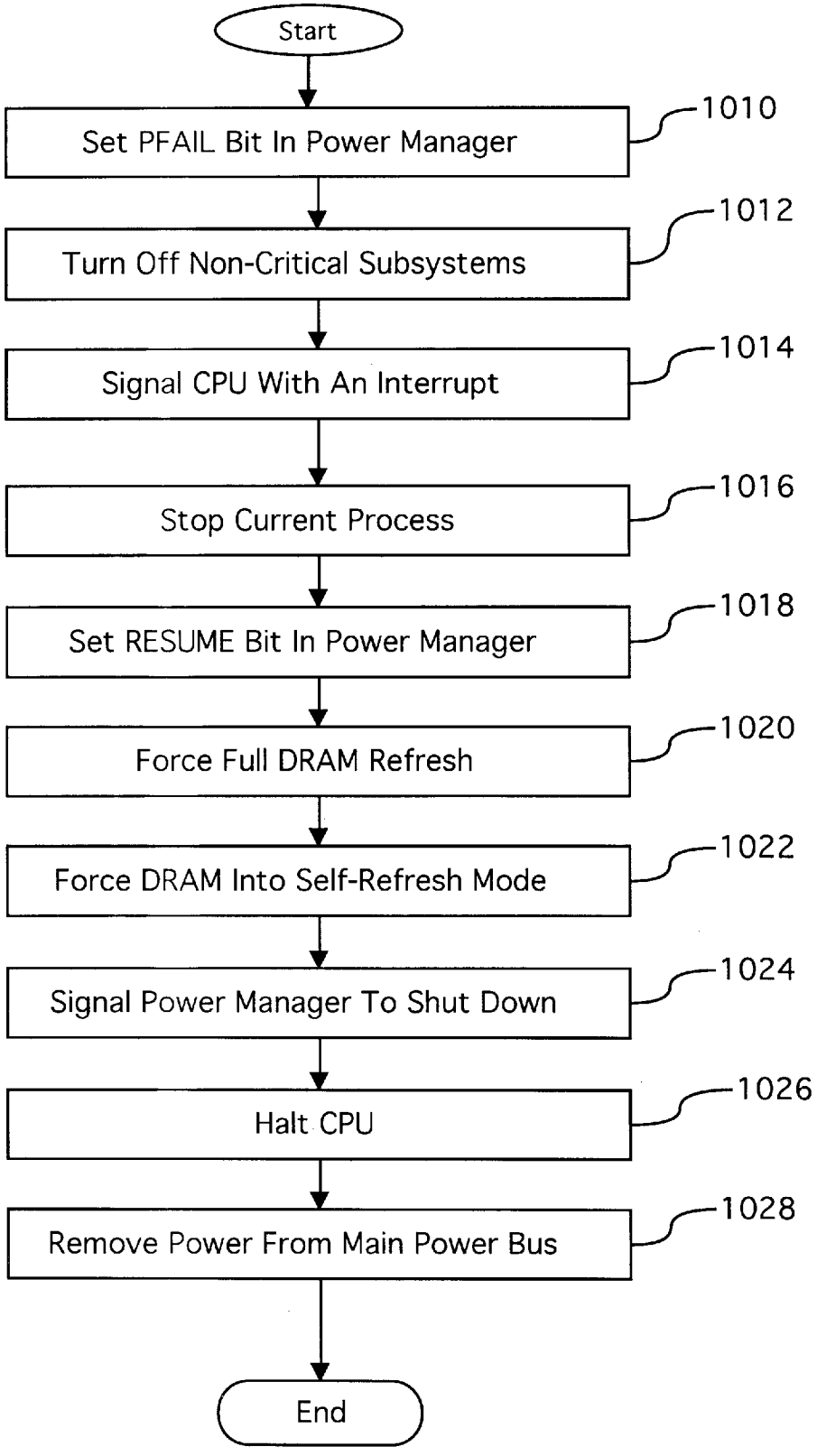

Start
Set PFAIL Bit In Power Manager
1010
Turn Off Non-Critical Subsystems
1012
Signal CPU With An Interrupt
1014
Stop Current Process
1016
Set RESUME Bit In Power Manager
1018
Force Full DRAM Refresh
1020
Force DRAM Into Self-Refresh Mode
1022
Signal Power Manager To Shut Down
1024
Halt CPU
1026
Remove Power From Main Power Bus
1028
End

FIG. 10

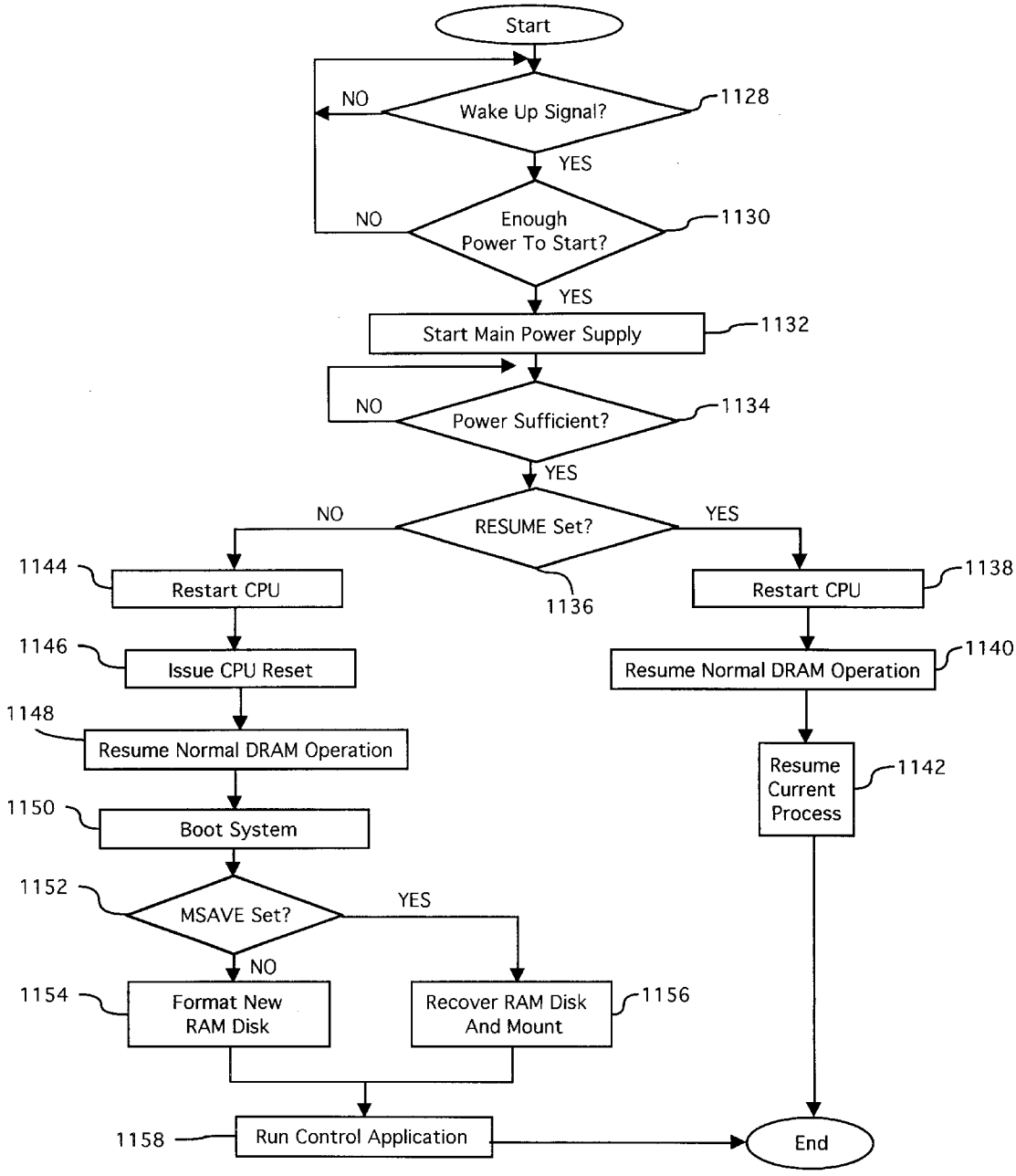

Start
Wake Up Signal?
1128
NO
YES
Enough Power To Start?
1130
NO
YES
Start Main Power Supply
1132
Power Sufficient?
1134
NO
YES
RESUME Set?
1136
NO
YES
1144
Restart CPU
1146
Issue CPU Reset
1148
Resume Normal DRAM Operation
1150
Boot System
1152
MSAVE Set?
YES
NO
1154
Format New RAM Disk
Recover RAM Disk And Mount
1156
1158
Run Control Application
1138
Restart CPU
1140
Resume Normal DRAM Operation
Resume Current Process
1142
End

FIG. 11

SYSTEM AND METHOD FOR MANAGING POWER CONDITIONS WITHIN A DIGITAL CAMERA DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application relates to co-pending U.S. patent application Ser. No. 08/702,246, entitled "System And Method For Recovering From A Power Failure Within A Digital Camera Device," filed on Aug. 23, 1996, and to co-pending U.S. patent application Ser. No. 08/719,264, entitled "System And Method For Conserving Power Within A Backup Battery Device," filed on Sep. 24, 1996, and to copending U.S. patent application Ser. No. 08/628,549, entitled "System And Method Using An LCD Indicator To Provide Status Of A Digital Camera Storage Device," filed on Apr. 10, 1996, which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to digital cameras and more particularly to a system and method for managing power conditions within a digital camera device.

2. Description of the Background Art

Current photographic technologies include various digital camera devices which capture image data by electronically scanning selected target objects. Digital camera devices typically process and compress the captured image data before storing the processed image data into internal or external memory devices. Furthermore, these digital camera devices may utilize multiple software routines running within a multi-threading environment to perform the various steps of capturing, processing, compressing and storing the image data.

Protecting the captured image data during the processing and compression stages (prior to final storage in non-volatile memory) is an important consideration of both camera manufacturers and camera users. Camera designers must therefore anticipate the occurrence of any events which might endanger the integrity of the captured image data.

A power failure in a digital camera device is one example of an event which might seriously jeopardize unprotected image data within the digital camera. For example, the digital camera may be performing a critical process at the time a power failure occurs. The intervening power failure may destroy the effect of the critical process and thus damage the image data or cause the digital camera to malfunction.

Furthermore, a power failure may interrupt various camera functions which typically resume their respective tasks whenever power is restored to the digital camera. The interrupted functions, however, would be unaware that a power failure had intervened. The interrupted functions would thus be unaware of the hardware reset which results from reapplying power after the power failure. This confusion between the system software and hardware would potentially endanger camera operations.

For the foregoing reasons, and because of other serious consequences of power failures in digital cameras, an improved system and method is needed for managing power conditions within a digital camera device, according to the present invention.

SUMMARY OF THE INVENTION

In accordance with the present invention, a system and method are disclosed for recovering from a power failure within a digital camera device. The preferred embodiment of the present invention includes central processing unit, a powerfail counter, a first-level interrupt handler, various interrupt service routines, a power manager and a voltage sensor.

In the preferred embodiment, the first-level interrupt handler initially sets the powerfail counter to a value of zero. Various interrupt service routines (each corresponding to a specific camera function or operation) may register themselves with the first-level interrupt handler (which coordinates all interrupts within the digital camera) to receive notification of an intervening power failure.

The power manager monitors the voltage sensor to detect a power failure within the digital camera. After detecting a power failure in which the camera operating power is less than a specified threshold value, the power manager generates a powerfail interrupt. The central processing unit responsively performs a powerfail powerdown sequence to preserve image data contained within the digital camera at the time of the intervening power failure. The power manager removes operating power from all non-critical subsystems and switches the critical subsystems to a backup power supply. The central processing unit and the camera's volatile memory are thus maintained in a static low-power mode, with all states preserved intact.

In the preferred embodiment, the first-level interrupt handler increments the powerfail counter to record the intervening power failure. The first level interrupt handler then notifies the registered interrupt service routines about the power failure restart and corresponding hardware reset.

After the power failure is remedied, the central processing unit performs a restart sequence to preserve any stored image data and to return the digital camera to a normal operational mode. The camera powerup sequence is performed in response to the contents of registers in the power manager. The power manager registers advantageously contain corresponding bits which indicate the conditions present in the camera at the time that the camera shutdown occurred. The present invention thus preserves the integrity of captured image data and effectively assists the digital camera to recover from an intervening power failure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a digital camera according to the present invention;

FIG. **2** is a block diagram of the preferred embodiment for the imaging device of FIG. **1**;

FIG. **3** is a block diagram of the preferred embodiment for the computer of FIG. **1**;

FIG. **4** is a memory map showing the preferred embodiment of the Read-Only Memory of FIG. **3**;

FIG. **5** is a memory map showing the preferred embodiment of the Dynamic Random-Access Memory of FIG. **3**;

FIG. **6** is a block diagram of the preferred embodiment of the power manager of FIG. **3**;

FIG. **7** is a block diagram of the preferred embodiment of the registers of FIG. **6**;

FIG. **8** is a flowchart of the preferred power states for the power manager of FIG. **3**;

FIG. **9** is a flowchart of preferred general method steps for recovering from a power failure according to the present invention;

FIG. **10** is a flowchart of preferred method steps for performing a powerfail powerdown sequence according to the present invention; and

FIG. **11** is a flowchart of preferred method steps for performing a powerup sequence according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention discloses a system and method for managing power conditions within a digital camera device and comprises a power manager for detecting and handling power failures, an interrupt handler for providing notice of power failures, service routines which register to receive notification of the power failure, and a processor for responsively controlling the digital camera during recovery from the power failure.

Referring now to FIG. **1**, a block diagram of a camera **110** is shown according to the present invention. Camera **110** preferably comprises an imaging device **114**, a system bus **116** and a computer **118**. Imaging device **114** is optically coupled to an object **112** and electrically coupled via system bus **116** to computer **118**. Once a photographer has focused imaging device **114** on object **112** and, using a capture button or some other means, instructed camera **110** to capture an image of object **112**, computer **118** commands imaging device **114** via system bus **116** to capture raw image data representing object **112**. The captured raw image data is transferred over system bus **116** to computer **118** which performs various image processing functions on the image data before storing it in its internal memory. System bus **126** also passes various status and control signals between imaging device **114** and computer **118**.

Referring now to FIG. **2**, a block diagram of the preferred embodiment of imaging device **114** is shown. Imaging device **114** preferably comprises a lens **220** having an iris, a filter **222**, an image sensor **224**, a timing generator **226**, an analog signal processor (ASP) **228**, an analog-to-digital (A/D) converter **230**, an interface **232**, and one or more motors **234**.

U.S. patent application Ser. No. 08/355,031, entitled "A System and Method For Generating a Contrast Overlay as a Focus Assist for an Imaging Device," filed on Dec. 13, 1994 is incorporated herein by reference and provides a detailed discussion of the preferred elements of imaging device **114**. Briefly, imaging device **114** captures an image of object **112** via reflected light impacting image sensor **224** along optical path **236**. Image sensor **224** responsively generates a set of raw image data representing the captured image **112**. The raw image data is then routed through ASP **228**, A/D converter **230** and interface **232**. Interface **232** has outputs for controlling ASP **228**, motors **234** and timing generator **226**. From interface **232**, the raw image data passes over system bus **116** to computer **118**.

Referring now to FIG. **3**, a block diagram of the preferred embodiment for computer **118** is shown. System bus **116** provides connection paths between imaging device **114**, power manager **342**, central processing unit (CPU) **344**, dynamic random-access memory (DRAM) **346**, input/output interface (I/O) **348**, read-only memory (ROM) **350**, and connector **352**. In the preferred embodiment, removable memory **354** may also connect to system bus **116** via connector **352**.

Power manager **342** communicates via line **366** with power supply **356** and coordinates power management operations for camera **110** as discussed below in conjunction with FIGS. **6–11**. CPU **344** typically includes a conventional processor device for controlling the operation of camera **110**. In the preferred embodiment, CPU **344** is capable of concurrently running multiple software routines to control the various processes of camera **110** within a multi-threading environment. DRAM **346** is a contiguous block of dynamic memory which may be selectively allocated to various storage functions by computer **118**. DRAM **346** includes a powerfail counter **347** which is incremented each time a power failure occurs in power supply **356**. DRAM **346** and powerfail counter **347** are further discussed below in conjunction with FIGS. **9–11**.

I/O **348** is an interface device allowing communications to and from computer **118**. For example, I/O **348** permits an external host computer (not shown) to connect to and communicate with computer **118**. I/O **348** also permits a camera **110** user to communicate with camera **110** via a set of externally-mounted user controls and via an external LCD display panel. ROM **350** typically comprises a conventional nonvolatile read-only memory which stores a set of computer-readable program instructions to control the operation of camera **110**. ROM **350** is further discussed below in conjunction with FIG. **4**. Removable memory **354** serves as an additional image data storage area and is preferably a non-volatile device, readily removable and replaceable by a camera **110** user via connector **352**. Thus, a user who possesses several removable memories **354** may replace a full removable memory **354** with an empty removable memory **354** to effectively expand the picture-taking capacity of camera **110**. In the preferred embodiment of the present invention, removable memory **354** is typically implemented using a flash disk.

Power supply **356** supplies operating power to the various components of camera **110**. In the preferred embodiment, power supply **356** provides operating power to a main power bus **362** and also to a secondary power bus **364**. The main power bus **362** provides power to imaging device **114**, I/O **348**, ROM **350** and removable memory **354**. The secondary power bus **364** provides power to power manager **342**, CPU **344** and DRAM **346**.

Power supply **356** is connected to main batteries **358** and also to backup batteries **360**. In the preferred embodiment, a camera **110** user may also connect power supply **356** to an external power source. During normal operation of power supply **356**, the main batteries **358** provide operating power to power supply **356** which then provides the operating power to camera **110** via both main power bus **362** and secondary power bus **364**.

During a power failure mode in which the main batteries **358** have failed (when their output voltage has fallen below a minimum operational voltage level) the backup batteries **360** provide operating power to power supply **356** which then provides the operating power only to the secondary power bus **364** of camera **110**. Selected components of camera **110** (including DRAM **346**) are thus protected against a power failure in the main batteries **358**.

Power supply **356** preferably also includes a flywheel capacitor connected to the power line coming from the main batteries **358**. If the main batteries **358** suddenly fail, the flywheel capacitor temporarily maintains the voltage from the main batteries **358** at a sufficient level, so that computer **118** can protect any image data currently being processed by camera **110** before shutdown occurs.

Voltage sensor **359** detects the voltage supplied by main batteries **358** and responsively provides the detected voltage reading to power manager **342**. The operation of power manager **342**, power supply **356** and voltage sensor **359** are further discussed below in conjunction with FIGS. **6–11**.

Referring now to FIG. **4**, a memory map showing the preferred embodiment of read-only memory (ROM) **350** is

shown. In the preferred embodiment, ROM **350** includes control application **400**, toolbox **402**, drivers **404**, kernel **406** and system configuration **408**. Control application **400** comprises program instructions for controlling and coordinating the various functions of camera **110**. Toolbox **402** contains selected function modules including memory manager **410** which is controlled by control application **400** and responsively allocates DRAM **346** storage locations depending upon the needs of computer **118** and the sets of received image data.

Drivers **404** control various components of camera **110** and include a first level interrupt handler (FLIH) **412** and various interrupt service routines (ISRs) **414**. In the preferred embodiment, FLIH **412** is a software routine which coordinates all interrupts within camera (**110**. FLIH **412** typically handles ordinary non-critical interrupts and also handles non-maskable critical interrupts such as a power failure in main batteries **358**. FLIH **412** preferably communicates with the various ISRs **414** which are each designed to handle a specific corresponding interrupt within camera **110**. FLIH **412** notifies the appropriate ISRs **414** via a "signal" when the interrupts occur. A signal is a mechanism used by multi-tasking operating systems for interprocess communications and synchronization.

For example, a camera **110** user may request zoom motor **234** to perform a zoom operation using lens **220**. When the requested zoom process is complete, an interrupt is generated to indicate that zoom motor **234** and lens **220** have reached their destination positions. The particular ISR **414** which corresponds to the foregoing zoom process then responsively handles the generated interrupt and provides a status update to higher-level routines, if necessary. In preferred embodiment, kernel **406** provides a range of basic underlying services for the camera **110** operating system. System configuration **408** performs initial start-up routines for camera **110**, including the boot routine and initial system diagnostics.

Referring now to FIG. **5**, a memory map showing the preferred embodiment of dynamic random-access memory (DRAM) **346** is shown. In the preferred embodiment, DRAM **346** includes working memory **530**, RAM disk **532** and system area **534**. Working memory **530** includes a powerfail counter **347**, frame buffers **536** (for initially storing sets of raw image data received from imaging device **114**) and image processing (IP) buffers **538** (for temporarily storing image data during the image processing and compression **420** process). In the preferred embodiment, power fail counter **347** stores a value which first-level interrupt handler **412** preferably increments each time voltage sensor **359** detects a power failure in main batteries **358**. Powerfail counter **347** is further discussed below in conjunction with FIGS. **9–11**. Working memory **530** may also contain various stacks, data structures and variables used by CPU **344** while executing the software routines used within computer **118**.

RAM disk **532** is a memory area used for storing raw and compressed image data and typically is organized in a "sectored" format similar to that of conventional hard disk drives. In the preferred embodiment, RAM disk **532** uses a well-known and standardized file system to permit external host computer systems, via I/O **348**, to readily recognize and access the data stored on RAM disk **532**. System area **534** typically stores data regarding system errors (for example, why a system shutdown occurred) for use by CPU **344** upon a restart of computer **118**.

Referring now to FIG. **6**, a block diagram of the preferred embodiment of power manager **342** (FIG. **3**) is shown. Power manager **342** includes bus interface **640**, registers **646**, state machine **650** and LCD generator **654**. Bus interface **640** is connected, via line **660**, to system bus **116** and may thus handle slave access of registers **646** within power manager **342** (typically by CPU **344**).

Registers **646** include a PCCR register, a PMCR register, a PSCR register and a PMIR register each described below in conjunction with FIG. **7**. Registers **646** also include external input pins (not shown) that asynchronously affect selected bit transitions within registers **646**. These input pins include PMRST_, MBFAIL_, MBALERT_, PWRSW_, IOSYS_, and USRRST_. The effect of these pin transitions is also dependent on the current state of power manager **342**. The following discussion describes the above-referenced register **646** input pins and the results of asserting each of these input pins via line **662**.

A logic level of value "0" on the PMRST_ pin causes all bits in the PCCR, PMIR and PMCR registers to be cleared to their inactive states. This action occurs regardless of the current state of power manager **342**. In response, power manager **342** will then transition to the IDLE_OFF state (described below). A "1 to 0" transition on the MBFAIL pin causes all bits in the PCCR register to be immediately deasserted if power manager **342** is in the IDLE_ON state (described below). This transition will also set the PwrFail bit to 1 in the PMCR register, the MBFail bit to 1 in the PMIR register, and assert the IRQ**0**_ pin. If power manager **342** is in any other state than IDLE_ON, any transition on this pin will be ignored. A "1 to 0" transition on the MBALERT pin will cause the Strobe power and control bits in the PCCR to be immediately deasserted if power manager **342** is in the IDLE_ON state. This transition will also set the MBAlert bit in the PMIR register to 1 and activate the IRQ**1**_ power alert interrupt. If power manager **342** is in any other state than IDLE_ON, any transition on this pin will be ignored.

In the preferred embodiment, a momentary switch may be used to cause a "1 to 0" transition on the PWRSW_ pin. The momentary "1 to 0" transition on the PWRSW_ pin will immediately set the UsrPwr bit to 1 in the PMCR register if power manager **342** is in the IDLE_OFF state. It will also initiate the PowerUp state sequencing. Furthermore, the momentary "1 to 0" transition on the PWRSW_ pin will immediately set the PDReq bit in the PMIR register if power manager **342** is in the IDLE_ON state. It will also cause the assertion of the IRQ**2**_ pin. If power manager **342** is in any other state than IDLE_ON or IDLE_OFF, the momentary transition on this pin will be ignored.

In an alternate embodiment without the above-mentioned momentary switch, a "1 to 0" transition on the PWRSW_ pin will immediately set the UsrPwr bit to 1 in the PMCR register if power manager **342** i s in the IDLE_OFF state. It will also initiate the PowerUp state sequencing. If power manager **342** is in any other state than IDLE_OFF, the "1 to 0" transition on this pin will be ignored.

A "0 to 1" transition on the PWRSW_ pin will immediately set the PDReq bit in the PMIR register if power manager **342** is in the IDLE_ON state. It will also cause the assertion of the IRQ**2**_ pin. If power manager **342** is in any other state than IDLE_ON, the "0 to 1" transition on this pin will be ignored.

A "1 to 0" transition on the IOSYS_ pin will immediately set the IOPwr bit to 1 in the PMCR register if power manager **342** is in the IDLE_OFF state. It will also initiate the PowerUp state sequencing. A "1 to 0" transition on the IOSYS_ pin will immediately set the IOReq bit in the PMIR

register if power manager **342** is in the IDLE_ON state. This transition will also cause the assertion of the IRQ**3**_ pin. A "1 to 0" transition on the USRRST_ pin will immediately set the USRRST bit to 1 in the PMCR register if power manager **342** is in the IDLE_ON state. This transition will also cause power manager **342** to issue a CPU **344** soft reset (SRST) for 30 us (one clock pulse of the 32 KHz real-time clock), starting at the next rise of PMCLK. CPU **344** will then hold SRST low for 16 ms. The PCCR and PMIR registers are also cleared. Additionally, all bits in the PMCR are cleared except for the USRRST bit. If power manager **342** is in any other state than IDLE_ON, any transition on this pin will be ignored. Power manager **342** will remain in the IDLE_ON state.

Registers **646** generate a series of interrupts onto line **664** in response to various conditions and states in camera **110**. Registers **646** and the generated interrupts are further discussed below in conjunction with FIGS. **7** and **8**. Registers **646** also provide signals to LCD generator **654** via line **670**. LCD generator **654** responsively generates and provides LCD outputs to an LCD display unit (not shown) via line **672**. The LCD display unit is preferably mounted on the exterior surface of camera **110** and forms part of a user interface for camera **110**.

In the preferred embodiment, power manager **342** has three main transition events called PowerUp, PowerDown and PowerDown w/Save. The PowerUp event occurs when power manager **342** is in the IDLE_OFF state and one of three external events occur. These external events occur when the user turns on the camera (PWRSW_low), when a timer wakeup (TEXP high) is signaled, and when the host attempts to connect to the camera (IOSYS_low). The PowerDown event occurs when power manager **342** is in the IDLE_ON state and the software writes a 1 to the PwrDwn bit in the PMCR and the MemSave bit in the PMCR is set to 0. The PowerDown w/Save occurs when power manager **342** is in the IDLE_ON state and the software writes a 1 to the Pwrdwn bit in the PMCR and the MemSave bit in the PMCR is set to 1.

Power manager **342** includes state machine **650** which preferably has eight main synchronous states. The following is a description of the main states and the events that trigger a transition into the particular state. The IDLE_OFF state is the initial state after PMRST_ is released. For the PowerUp sequence, power manager **342** starts from IDLE_OFF, moves through two more states and ends with the IDLE_ON state.

The IDLE_OFF_SAVE state is entered from the IDLE_ON state when the MemSave option is specified. For the PowerUp sequence, power manager **342** starts from IDLE_OFF_SAVE, moves through two more states and ends with the IDLE_ON state. The IDLE_ON is the end state for a PowerUp sequence. In the PowerDown sequence, power manager **342** starts from IDLE_ON and ends in IDLE_OFF or IDLE_OFF_SAVE.

In the preferred embodiment, there are two types of PowerDown sequences called PWRDWN_NORM and PWRDWN_SAVE. The PWRDWN_NORM sequence executes various steps to PowerDown camera **110** before entering an idle state. This sequence is executed if the software writes a 1 to the PwrDwn bit in the PMCR when power manager **342** is in the IDLE_ON state and the MemSave bit in the PMCR is programed to 0. The PWRDWN_SAVE sequence executes various steps to PowerDown camera **110** before entering an idle state. This sequence is entered if the software writes a 1 to the PwrDwn bit in the PMCR when power manager **342** is in the IDLE_ON state and the MemSave bit in the PMCR is programmed to 1.

The CNT_PRE_WAIT state is used to wait for voltage sensor **359** to start operation. When the desired time has passed, power manager **342** will continue the PowerUp sequence and move to the CNT_WAIT state which is used to wait for the test of main batteries **358** to complete. When the desired time has passed, power manager **342** will continue the PowerUp sequence and move to the POR_IRQ_WAIT state.

The CNT_PRE_WAIT_SAVE is also used to wait for voltage sensor **359** to start operation. When the specified time has passed, power manager **342** continues the (PowerUp sequence and also switches to the CNT_WAIT_SAVE state. The CNT_WAIT_SAVE state is used to wait for testing of main batteries **358** to complete while the MemSave is specified. When the desired time has passed, power manager **342** will continue the PowerUp sequence and move to the POR_IRQ_WAIT state. The POR_IRQ_WAIT state is used to wait one PMCLK cycle for power manager **342** to drive the POR_ signal or to deassert the IRQ**0**_ interrupt before transitioning to the IDLE_ON state.

State machine **650** receives, via line **668**, a real-time clock which preferably operates at a 32 KHz rate. In the preferred embodiment, state machine **650** also generates a power control signal which is supplied to power supply **356** via line **366** to advantageously control the operation of power supply **356** according to the present invention.

Referring now to FIG. **7**, a block diagram of the preferred embodiment of registers **646** is shown. In the preferred embodiment, registers **646** include power and clock control register (PCCR) **730**, power manager control register (PMCR) **732**, power system condition register (PSCR) **734** and power manager interrupt register (PMIR) **736**.

PCCR **730** is an 8-bit read/write register which includes the following binary fields. Bits **6–7** of PCCR **730** correspond to a field named I/O. The IO field is an I/O Enable and these bits control which I/O system is engaged and in full power mode. If the I/O field is 00, then no I/O is enabled and if the I/O field is 01, then the serial port is enabled. If the I/O field is 10, then USB is enabled and if the I/O field is 11, then IRDA is enabled.

Bit **5** of PCCR **730** corresponds to a field named LCDCtrl. The LCDCrtl field is a LCD and backlight power control. Bit **4** of PCCR **730** corresponds to a field named AudioEn. The AudioEn field is an audio system clock and power enable. Bit **3** of PCCR **730** corresponds to a field named ICHC**1**k. The ICHC**1**k field is an image capture head clock enable. Bit **2** of PCCR **730** corresponds to a field named ICHPwr. The ICHPwr field is an image capture head power control (and also controls LED power). Bits **0–1** of PCCR **730** correspond to a field named ICHStrb. The ICHStrb field is an image capture head strobe power control and level. Both bits are cleared by the Power Alert condition.

All bits of PCCR **730** are placed in their deasserted state by the Power Fail condition. The ICHstrb bits are cleared by the Power Alert condition. All bits correspond to pins on the power manager **342** ASIC. Software controls the setting or clearing of the bits to power down subsystems. All bits are placed in their deasserted state during PMRST_.

PMCR **732** is an 8-bit read/write register which is the main control center of power manager **342**. All bits are cleared to zero during PMRST_. PMCR **732** preferably includes the following binary fields. Bit **7** of PMCR **732**

corresponds to a field named RESUME. The RESUME field is set and cleared by software and is set for power failure shutdown or "instant-on shutdown". RESUME prevents reset of CPU **344** on start-up. Bit **6** of PMCR **732** corresponds to a field named MSAVE. The MSAVE field is set and cleared by software and is set to maintain power to DRAM **346** and CPU **344** in Shut Down mode. MSAVE is also used to generate an LCD status indication during main power off/on.

Bit **5** of PMCR **732** corresponds to a field named DiskIU. The DiskIU field is set and cleared by software and is set when the DiskInUse indicator on the status LCD is required. The status LCD maintains this display with main power off/on. Bit **4** of PMCR **732** corresponds to a field named PwrDwn. The PwrDwn field is set by software to initiate power down from power manager **342**. CPU **344** enters Power Down Mode or Deep Steep Mode **1** PMCLK cycle following the next rising edge of PMCLK after setting this bit. This bit is cleared on Power Up sequence by power manager **342**. While power manager **342** is clearing this bit during the PowerOn sequence, writes to this bit will be disabled.

Bit **3** of PMCR **732** corresponds to a field named UserPwr. The UserPwr field is set during the normal power up sequence if initiated by a user pressing the main power switch (PWRSW input). UserPwr is cleared by software writing a 1 to this bit. Bit **2** of PMCR **732** corresponds to a field named IOPwr. The IOPwr field is set during the normal power up sequence if initiated by the external communications port **348** (IOSYS_ input). If neither UserPwr, IOPwr, or UserRst is set, software will assume a timer initiated restart has occurred. Bit **1** of PMCR **732** corresponds to a field named UserRst. The UserRst field is set by the user pressing the RESET button (USERRST_ input) and is cleared by software by writing a 1 to this bit during boot. If neither PwrFail or UserRst is set, software assumes a normal power up. Bit **0** of PMCR **732** corresponds to a field named PwrFail. The PwrFail field is set at the "0 to 1" transition of the MBFail bit in PSCR **734**. The PwrFail field is cleared by software writing a 1 to this bit after restart.

PSCR **734** is an 8-bit read-only register with the following fields. Bit **7** of PSCR **734** corresponds to a field named BBOK. The BBOK field indicates the backup batteries **360** contain sufficient operating power (above 4.5 volts). Bit **6** of PSCR **734** corresponds to a field named MBStart. The MBStart field corresponds to the main batteries **358** START level (above 6.0 volts). MBStart indicates that there is enough energy to do a camera **110** startup. Bit **5** of PSCR **734** corresponds to a field named MBLow. The MBLow field indicates that main batteries **358** are above 6.4 volts. Bit **4** of PSCR **734** corresponds to a field named MBGood. The MBGood field indicates that main batteries **358** are above 6.9 volts. Bit **3** of PSCR **734** corresponds to a field named MBFull. The MBFull field indicates that main batteries **358** are above 7.4 volts. Bit **2** of PSCR **734** corresponds to a field named ACPwr. The ACPwr field indicates that external AC power is being supplied to the camera via an external power adapter. Bit **1** of PSCR **734** corresponds to a field named MBAlert. MBAlert indicates an ALERT condition for main batteries **358** (below 5.4 volts). This bit reflects the current level of the MBALERT_ input. A "1 to 0" transition on the MBALERT_ pin generates an alert interrupt (IRQ1_ output), sets the Pfail bit in PMIR **736** to 1, and clears two bits in PCCR **730**. Bit **0** of PSCR **734** corresponds to a field named MBFail. The MBFail field indicates a PwrFail in main batteries **358** (below 5.2 volts) and reflects the current level of the MBFAIL_ input. A "1 to 0" transition on the MBFAIL_ pin generates a power failure interrupt (IRQ0_ output), sets the MBALERT bit in PMIR **736**, deasserts all bits in PCCR **730**, and sets the PwrFail bit in PMCR **732**. PSCR **734** thus indicates the state of eight power system conditions.

PMIR **736** is an 8-bit read/write register with the following fields. Bits **4–7** of PMIR **736** correspond to a field named Reserved. The Reserved field always reads 0 and is reserved for potential future functionality in camera **110**. Bit **3** of PMIR **736** corresponds to a field named IOReq. The IOReq field is a request from the external communications port **348** of camera **110**. A "1 to 0" transition on the IOSYS_ pin while power manager **342** is in the IDLE_ON state generates an IOReq interrupt (IRQ3_output). A write of 1 to this bit will immediately clear the interrupt.

Bit **2** of PMIR **736** corresponds to a field named PwrDwn. The PwrDwn field is a power down request generated by a camera **110** user (PWRSW pin). A "0 to 1" transition on the PWRSW_ pin generates a PwrDwn interrupt (IRQ2_ output). A write of 1 to this bit will immediately clear the interrupt. Bit **1** of PMIR **736** corresponds to a field named MBAlert. The MBAlert field indicates an ALERT condition (below 5.4 volts) for main batteries **358**. A "1 to 0" transition on the MBALERT_ pin immediately generates an ALERT interrupt (IRQ1_ output) and clears two bits in the PCCR **730**. A write of 1 to this bit will immediately clear the interrupt. Bit **0** of PMIR **736** corresponds to a field named MBFail. The MBFail field indicates a power failure condition (below 5.2 volts) in main batteries **358**. A "1 to 0" transition on the MBFail_ pin generates a PwrFail interrupt (IRQ0_ output), deasserts all bits in the PCCR **730**, and sets the PwrFail bit in the PMCR **732**. A write of 1 to this bit will immediately clear the interrupt. PMIR **736** thus indicates the interrupt status of camera **110** and is also used to clear the interrupts. All bits are cleared during PMRST_.

Referring now to FIG. **8**, a flowchart of the preferred power states for power manager **342** is shown. Initially, in step **810**, camera **110** is in the SHIP state with neither main batteries **358** nor backup batteries **360** installed. In steps **812** and **814**, the SHIP to INIT transition occurs when power is first applied to the camera **110**, either from backup batteries **360**, main batteries **358**, or via external power.

In steps **816** and **818**, the INIT to RUN transition occurs when the user turns on camera **110** (PWRSW low transition) or when the host computer attempts to connect to camera **110** (IOSYS low transition). CPU **344** is in POWER DOWN MODE prior to this transition. Following step **818**, the FIG. **8** sequence proceeds either to step **820**, **826** or **832**, depending on the type of shutdown occurring in camera **110**.

In steps **820** and **822**, a CLEAR state may be entered if a shutdown occurs without images in DRAM **346**. The RUN to CLEAR transition occurs when a user turns off camera **110** (PWRSW high transition), a host or script command to shut down camera **110** occurs, camera **110** times out after no activity, or camera **110** enters a timed shutdown. In the CLEAR state, the MSAVE bit in PMCR **732** is set to zero and the RESUME bit in PMCR **732** is also set to zero.

In steps **826** and **828**, a SAVE state may be entered if a shutdown occurs with images in DRAM **346**. The RUN to SAVE transition occurs when a user turns off camera **110** (PWRSW high transition, followed by software response to interrupt), a host or script command to shut down camera **110** occurs, camera **110** times out after no activity, or camera **110** enters a timed shutdown. In the SAVE state, the MSAVE bit in PMCR **732** is set to one and the RESUME bit in PMCR **732** is set to zero. In steps **832** and **834**, a RESUME

state may be entered if a shutdown occurs due to a power failure in main batteries **358** or instant-on shutdown. In the RESUME state, the MSAVE bit in PMCR **732** is set to one and the RESUME bit in PMCR **732** is also set to one.

In steps **824**, **830** and **818**, a CLEAR to RUN transition may occur if a user turns on camera **110** (PWRSW low transition), a timer wakeup (TEXP) is signaled or if the host computer attempts to connect to camera **110** (IOSYS low transition). CPU **344** is in POWER DOWN MODE prior to this transition. In steps **824**, **830** and **818**, a SAVE to RUN transition may occur if a user turns on camera **110** (PWRSW low transition), a timer wakeup (TEXP) is signaled or when the host computer attempts to connect to camera **110** (IOSYS low transition). CPU **344** is in DEEP SLEEP MODE prior to this transition. In steps **834**, **836** and **838**, a RESUME to RUN transition may occur if a wake up of CPU **344** is signaled and a user turns on camera **110** (PWRSW low transition), a timer wakeup (TEXP) is signaled or the host computer attempts to connect to camera **110** (IOSYS low transition).

In FIG. **8**, power manager **342** thus sequentially enters the SHIP state, the INIT state and the RUN state. Power manager **342** then may enter either the CLEAR state, the SAVE state or the RESUME state, depending on the particular shutdown conditions. Finally, power manager **342** typically transitions back to the RUN state to recommence normal operation, in accordance with the present invention.

Referring now to FIG. **9**, a flowchart of preferred general method steps for recovering from a power failure is shown. Initially, a user applies **940** power to camera **110** by installing main batteries **358** and backup batteries **360**, and then activating an externally-mounted power on-off switch. First-level interrupt handler (FLIH) **412** then sets **942** powerfail counter **347** to a value of zero. Next, various interrupt service routines **414** register **944** with the first level interrupt handler **412** to request notification in the event of a power failure in main batteries **358**.

CPU **344** then runs **946** control application **400** to operate camera **110** in normal operation mode which captures, processes, compresses and stores sequential sets of image data. In normal operation mode, CPU **344** periodically requests the execution of various critical processes. In the preferred embodiment, CPU **344** repeatedly checks powerfail counter **347** to determine whether a critical process has been interrupted by an intervening power failure.

Next, voltage sensor **359** senses **948** the voltage level of main batteries **358** and provides power manager **342** with the sensed voltage level. Power manager **342** then determines **950** whether the voltage level of main batteries **358** is greater than a predetermined threshold voltage level. The threshold value is typically selected to be incrementally higher than the minimum operating voltage (to permit orderly shutdown of the camera **110** processes). If the voltage of main batteries **358** is greater than the selected threshold value, then the FIG. **9** process repeats the steps **946**, **948** and **950**.

However, if the voltage of main batteries **358** is not greater **950** than the predetermined threshold value, then power manager **342** generates **952** a powerfail interrupt. In the preferred embodiment, the powerfail interrupt may be disabled in rare cases in which a sequence of CPU **344** instructions must never be interrupted by a power failure. Any disabling of the powerfail interrupt, however, is restricted to a very short period of time. Next, CPU **344** receives the generated powerfail interrupt and responsively performs **954** a powerfail powerdown sequence to protect the image data currently within camera **110**. The powerfail powerdown sequence is further discussed below in conjunction with FIG. **10**.

The camera **110** user may then replace **655** the main batteries **358** and activate the camera **110** power on/off switch. CPU **344** then performs **956** a powerup sequence to bring camera **110** back to normal operating mode while also preserving any existing image data. FLIH **412** then increments **958** powerfail counter **347** to indicate the occurrence of a power failure in main batteries **358**. Alternately, powerfail counter **347** may be a hardware register which is incremented in power manager **342**.

The first level interrupt handler **412** then notifies **960** any registered interrupt service routines **414** about the power failure restart so that the interrupt service routines **414** are aware that their corresponding hardware components have been reset by the power failure and the subsequent camera **110** powerup. The power failure notification allows the registered interrupt service routines **414** to run depending upon their relative task priority. Typically, this notification is accomplished through the use of a signal or semaphore which wakes up the interrupt service routine.

In alternate embodiments, the interrupt service routines may operate in cooperation with various other system routines. These cooperating routines thus may form various hierarchical networks which operate in synchronous or asynchronous modes. For example, a particular interrupt service routine may function in response to a device driver. The device driver, in turn, may function in response to an application program. In such cases, the interrupt service routines typically propagate their received power failure notification to any related routines in the network which require notification of the power failure restart. Finally, the FIG. **9** process then returns to step **946** and CPU **344** runs control application **400** to operate camera **110** in normal operation mode, as discussed above.

Referring now to FIG. **10**, a flowchart of preferred method steps for performing a powerfail powerdown sequence according to the present invention is shown. Initially, power manager **342** sets **1010** a PFAIL bit which records the occurrence of a power failure so that computer **118** software routines may subsequently access this information when needed. Next, power manager **342** turns off **1012** all non-critical subsystems. Power manager **342** then signals **1014** CPU **344** with an interrupt and CPU **344** responsively stops **1016** the current process.

Next, CPU **344** sets **1018** the RESUME bit in power manager **342** to indicate that CPU **344** should not be reset in a subsequent powerup of camera **110**. CPU **344** then forces **1020** a full refresh of DRAM **346** and then forces **1022** DRAM **346** into a self-refresh mode. Next, CPU **344** signals **1024** power manager **342** to shut down and then CPU **344** halts **1026** operation. After halting, CPU **344** still receives operating power from backup batteries **360** and is essentially stopped "in place." In this static mode, system, bus **116** is in a tri-state condition and the CPU **344** clock is stopped. All CPU **344** states, however, are still intact (for example, the registers, program counter, cache and stack are preserved intact) and image data in DRAM **346** is also preserved intact. Next, power manager **342** removes **1028** operating power from main power bus **362**. The FIG. **10** powerfail powerdown sequence is then complete.

Referring now to FIG. **11**, a flowchart of preferred method steps for performing a powerup sequence according to the present invention is shown. Initially, CPU **344** waits **1128** for a "wake up" signal which is typically generated in

response to the activation of a camera **110** power on-off switch. After the "wake up" signal is generated, power manager **342** determines **1130** whether power supply **356** is generating enough operating power to start camera **110**. If sufficient operating power is present, power manager **342** starts **1132** power supply **356** in normal mode with the main batteries **358** providing operating power to power supply **356** which then responsively provides the operating power to main power bus **362** and also to secondary power bus **364**. Next, power manager **342** determines **1134** whether the generated operating power is maintaining a sufficient voltage level.

If operating power is sufficient in camera **110**, power manager **342** then determines **1136** whether a RESUME bit has been set. In the preferred embodiment, CPU **344** sets the RESUME bit in response to a power failure in order to indicate that CPU **344** should not be reset in a subsequent powerup of camera **110**. If the RESUME bit has been set, power manager **342** restarts **838** the CPU **344**. The CPU **344** then resumes **1140** normal operation of DRAM **346** and also resumes **1142** the camera **110** process which was interrupted by the intervening power failure.

If the RESUME bit has not been set, then power manager **342** restarts **1144** the CPU **344** and issues **1146** a CPU **344** reset. CPU **344** then resumes **1148** normal operation of DRAM **346** and boots **1150** the computer **110** system using the system configuration **408** routine. Next, CPU **344** determines **1152** whether a MSAVE bit has been set in power manager **342**. In the preferred embodiment, CPU **344** sets the MSAVE bit to specify that RAM disk **532** contains image data that should be saved upon restart of computer **118**. If the MSAVE bit has not been set, computer **118** formats **1154** a new RAM disk **532**. CPU **344** then runs **1158** control application **400** for normal operation of camera **110**. In step **1152**, if the MSAVE bit has been set, then CPU **344** recovers and mounts **1156** RAM disk **532**. CPU **344** then runs **1158** control application **400** for normal operation of camera **110**. The powerup process of FIG. **11** then ends.

The invention has been explained above with reference to a preferred embodiment. Other embodiments will be apparent to those skilled in the art in light of this disclosure. For example, power manager **342** may contain various registers **646** other than those discussed above in the preferred embodiment. Therefore, these and other variations upon the preferred embodiment are intended to be covered by the present invention, which is limited only by the appended claims.

What is claimed is:

1. A system for managing power conditions in a digital camera device, comprising:

a processor coupled to said digital camera device for controlling said digital camera device; and

a power manager coupled to said processor, said power manager including registers for containing status information, interrupt information, and control information;

said power manager providing said status information, said interrupt information, and said control information to said processor for controlling said digital camera device.

2. The system of claim **1** wherein said conditions include a low power level condition to which said processor responsively performs a powerdown sequence and a powerup sequence to protect data including captured image data in said digital camera device.

3. The system of claim **1** wherein said power manager uses a sensor device to obtain said power state information from a power source coupled to said digital camera device.

4. The system of claim **1** wherein said power manager further comprises a control register for storing said control information, an interrupt register for storing said interrupt information, and a condition register for storing said status information.

5. The system of claim **1** wherein said control information indicates the contents of memory devices coupled to said digital camera device.

6. The system of claim **5** wherein said control information includes a RESUME bit and a MSAVE bit which said power manager uses to indicate shutdown states for said digital camera device.

7. The system of claim **1** wherein said power manager further comprises a state machine, a LCD generator and a bus interface.

8. The system of claim **1** wherein said processor generates selected interrupts to control said digital camera device in response to said interrupt information from said power manager.

9. A method for managing power conditions in a digital camera device, comprising the steps of:

controlling said digital camera device with a processor coupled to said digital camera device;

storing status information, interrupt information, and control information in a power manager coupled to said processor; and

providing said status information, said interrupt information, and said control information to said processor for controlling said digital camera device.

10. The method of claim **9** wherein said conditions include a low power level condition to which said processor responsively performs a powerdown sequence and a powerup sequence to protect data including captured image data in said digital camera device.

11. The method of claim **9** wherein said power manager uses a sensor device to obtain said power state information from a power source coupled to said digital camera device.

12. The method of claim **9** wherein said power manager further comprises a control register for storing said control information, an interrupt register for storing said interrupt information, and a condition register for storing said status information.

13. The method of claim **9** wherein said control information indicates the contents of memory devices coupled to said digital camera device.

14. The method of claim **13** wherein said control information includes a RESUME bit and a MSAVE bit which said power manager uses to indicate shutdown states for said digital camera device.

15. The method of claim **9** wherein said power manager further comprises a state machine, a LCD generator and a bus interface.

16. The method of claim **9** wherein said processor generates selected interrupts to control said digital camera device in response to said interrupt information from said power manager.

17. A computer-readable medium comprising program instructions for managing power conditions in a digital camera device by performing the steps of:

controlling said digital camera device with a processor coupled to said digital camera device;

storing status information, interrupt information, and control information in a power manager coupled to said processor; and

providing said status information, said interrupt information, and said control information to said processor for controlling said digital camera device.

18. A system for managing power conditions in a digital camera device, comprising:

means for controlling said digital camera device with a processor coupled to said digital camera device;

means for storing status information, interrupt information, and control information in a power manager coupled to said processor; and

means for providing said status information, said interrupt information, and said control information to said processor for controlling said digital camera device.

* * * * *

EXHIBIT F

US007633076B2

(12) **United States Patent**
Huppi et al.

(10) **Patent No.: US 7,633,076 B2**
(45) **Date of Patent: Dec. 15, 2009**

(54) **AUTOMATED RESPONSE TO AND SENSING OF USER ACTIVITY IN PORTABLE DEVICES**

(75) Inventors: **Brian Huppi**, San Francisco, CA (US); **Anthony M. Fadell**, Portola Valley, CA (US); **Derek Barrentine**, Cupertino, CA (US); **Daniel Freeman**, Santa Cruz, CA (US)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 385 days.

(21) Appl. No.: **11/586,862**

(22) Filed: **Oct. 24, 2006**

(65) **Prior Publication Data**

US 2007/0075965 A1 Apr. 5, 2007

Related U.S. Application Data

(63) Continuation-in-part of application No. 11/241,839, filed on Sep. 30, 2005, and a continuation-in-part of application No. 11/240,788, filed on Sep. 30, 2005.

(51) **Int. Cl.**
G01N 21/86 (2006.01)
G01V 8/00 (2006.01)
G01N 21/88 (2006.01)

(52) **U.S. Cl.** **250/559.36**; 340/686.6; 381/107; 345/169

(58) **Field of Classification Search** 250/559.36; 340/686.6; 381/107; 345/169
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,103,085	A	4/1992	Zimmerman
5,528,266	A	6/1996	Arbeitman et al.
5,684,294	A	11/1997	Kouhi
6,373,612	B1	4/2002	Hoffman et al.
6,520,013	B1	2/2003	Wehrenberg
6,583,676	B2	6/2003	Krah et al.
6,601,012	B1	7/2003	Horvitz et al.
6,664,744	B2	12/2003	Dietz

(Continued)

FOREIGN PATENT DOCUMENTS

EP	1185058	3/2002

(Continued)

OTHER PUBLICATIONS

Agilent Technologies Inc., "Agilent unveils optical proximity sensor for mobile appliances", http:/www.embeddedstar.com/press/content/2004/8/embedded16015.html, (Aug. 31, 2004),2 pages.

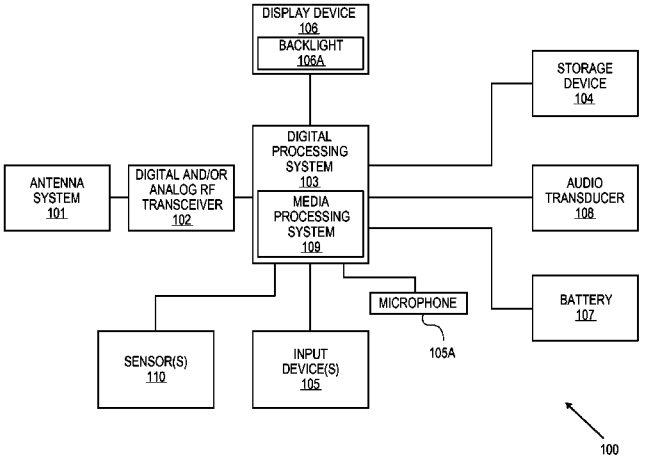
(Continued)

Primary Examiner—Seung C Sohn
(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman LLP

(57) **ABSTRACT**

The various methods and devices described herein relate to devices which, in at least certain embodiments, may include one or more sensors for providing data relating to user activity and at least one processor for causing the device to respond based on the user activity which was determined, at least in part, through the sensors. The response by the device may include a change of state of the device, and the response may be automatically performed after the user activity is determined.

18 Claims, 17 Drawing Sheets



U.S. PATENT DOCUMENTS

6,812,466	B2	11/2004	O'Connor et al.
6,822,635	B2	11/2004	Shahoian et al.
6,947,571	B1	9/2005	Rhoads et al.
6,956,564	B1	10/2005	Williams
7,016,705	B2	3/2006	Bahl et al.
7,019,622	B2	3/2006	Orr et al.
7,171,221	B1	1/2007	Amin et al.
7,522,065	B2	4/2009	Falcon
2001/0031633	A1	10/2001	Tuomela et al.
2002/0167488	A1	11/2002	Hinckley et al.
2003/0095096	A1	5/2003	Robbin et al.
2004/0180649	A1	9/2004	Vogel et al.
2004/0224638	A1	11/2004	Fadell et al.
2004/0233153	A1	11/2004	Robinson
2004/0245438	A1	12/2004	Payne et al.
2005/0219223	A1	10/2005	Kotzin et al.
2005/0219228	A1	10/2005	Alameh et al.
2005/0221791	A1	10/2005	Angelhag
2006/0017692	A1	1/2006	Wehrenberg et al.
2006/0026521	A1	2/2006	Hotelling et al.
2006/0026535	A1	2/2006	Hotelling et al.
2006/0060762	A1	3/2006	Chan et al.
2006/0097991	A1	5/2006	Hotelling et al.
2006/0117108	A1	6/2006	Salisbury et al.
2006/0146012	A1	7/2006	Arneson et al.
2006/0161870	A1	7/2006	Hotelling et al.
2006/0161871	A1	7/2006	Hotelling et al.
2006/0164241	A1	7/2006	Makela et al.
2006/0290921	A1	12/2006	Hotelling
2007/0075965	A1	4/2007	Huppi et al.
2007/0085157	A1	4/2007	Fadell et al.
2007/0099574	A1	5/2007	Wang
2008/0006762	A1	1/2008	Fadell et al.
2008/0090617	A1	4/2008	Sutardja
2008/0113618	A1	5/2008	De Leon et al.

FOREIGN PATENT DOCUMENTS

EP	1335430	8/2003
EP	1355223	10/2003
EP	1452988	9/2004
EP	1507132	2/2005
EP	1507196	2/2005
EP	1650938	4/2006
GB	2346500	8/2000
JP	05-323277	12/1993
JP	2007-163872	6/2007
WO	WO-2004/093045	10/2004
WO	WO-2005/101176	10/2005

OTHER PUBLICATIONS

Apple Inc., "PCT Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority", PCT/US2007/022335, (Feb. 18, 2008).

Kennedy, "Methods and Apparatuses for Configuration Automation", U.S. Appl. No. 10/805,144, 59 pages.

Roos, Gina "Agilent's new proximity sensor beats the fumble-fingered competition hands down . . . literally", eeProductCenter, URL:http://www.eeproductcenter.com/showArticle.jhtml?articleID_46200544, (Sep. 1, 2004),3 pages.

Universial Remote Control, Inc., "MX-950 (The Aurora)", www.unversalremote.com, (2005).

Universal Remote Control, Inc., "All Complete Control Remotes Now Use Narrow Band RF", http://www.universalremote.com/corporate/press_release.php?press=13, (2008).

Universal Remote Control, Inc., "Operating System with the Aurora MX-950", MX-950 Owners Manual, (2005).

Apple Inc., "PCT Search Report and Written Opinion mailed Jul. 3, 2008", PCT/US2007/023124, 14 pages.

PCT Search Report mailed Aug. 21, 2008; PCT/US2007/026130.

CNET News.com, "Reinventing the Scroll Wheel," Photo 1, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-1.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 2, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-2.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 3, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-3.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 4, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-4.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 5, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-5.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 6, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-6.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 7, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-7.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

CNET News.com, "Reinventing the Scroll Wheel," Photo 8, downloaded from the Internet at: http://news.com.com/2300-1041_3-6107951-8.html?tag=ne.gall.pg, Aug. 22, 2006, 2 pages.

"Apple Inc.", *International Preliminary Report on Patentability* mailed May 28, 2009; PCT Application No. PCT/US2007/023124.

"Apple Inc.", *International Preliminary Report on Patentability* mailed May 7, 2009; PCT Application No. PCT/US2007/022335.

"Apple Inc.", *International Preliminary Report on Patentability* mailed Jul. 16, 2009; PCT Application No. PCT/US2007/026164.

"Apple Inc.", *International Preliminary Report on Patentability* mailed Jul. 16, 2009; PCT Application No. PCT/US2007/026141.

"Proximity Sensor Demo Kit User Guide, Version 0.62-Preliminary", *Integration Associates, Inc.*; 2004, 17 pages.

Apple Inc., *International Preliminary Report on Patentability* mailed Jul. 16, 2009; PCT Application No. PCT/US2007/026130.

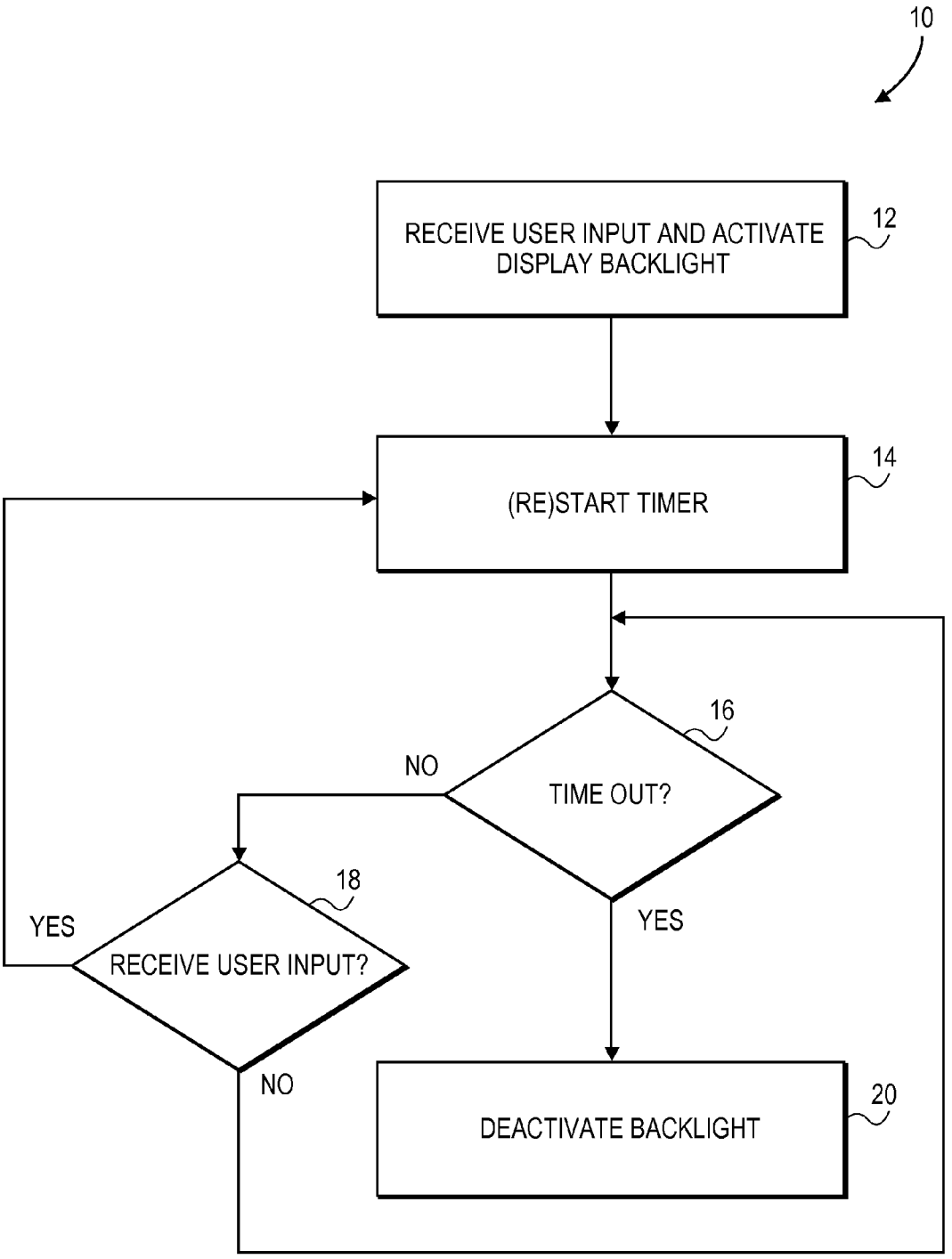

10
RECEIVE USER INPUT AND ACTIVATE DISPLAY BACKLIGHT
12
(RE)START TIMER
14
16
TIME OUT?
NO
YES
18
RECEIVE USER INPUT?
YES
NO
DEACTIVATE BACKLIGHT
20

FIG. 1

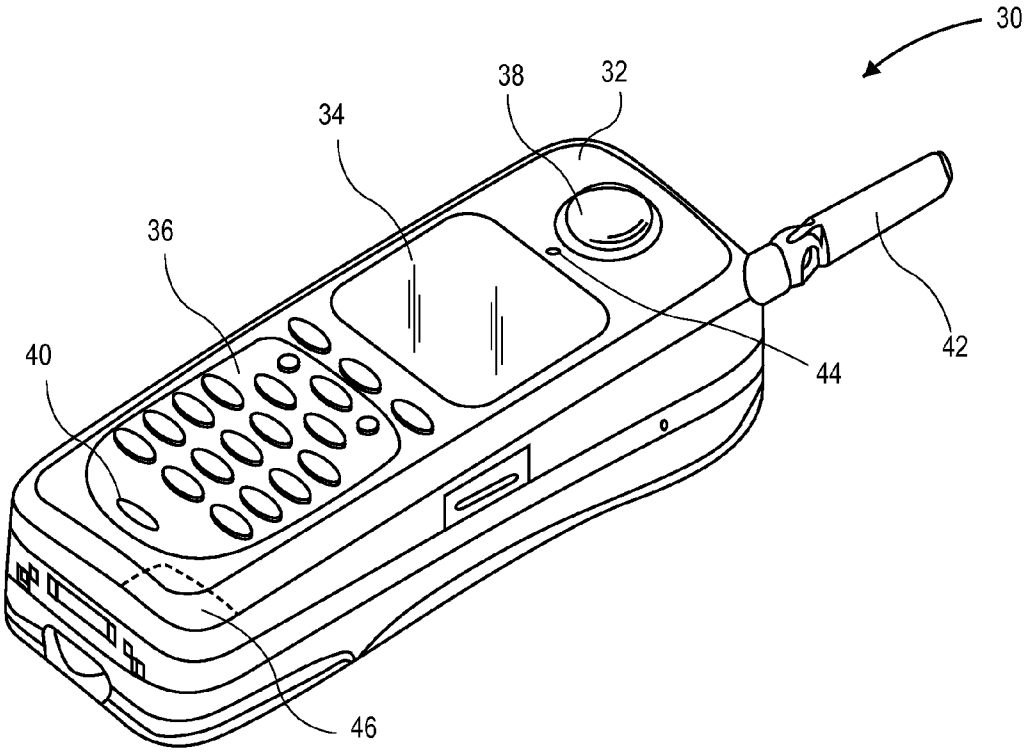


FIG. 2

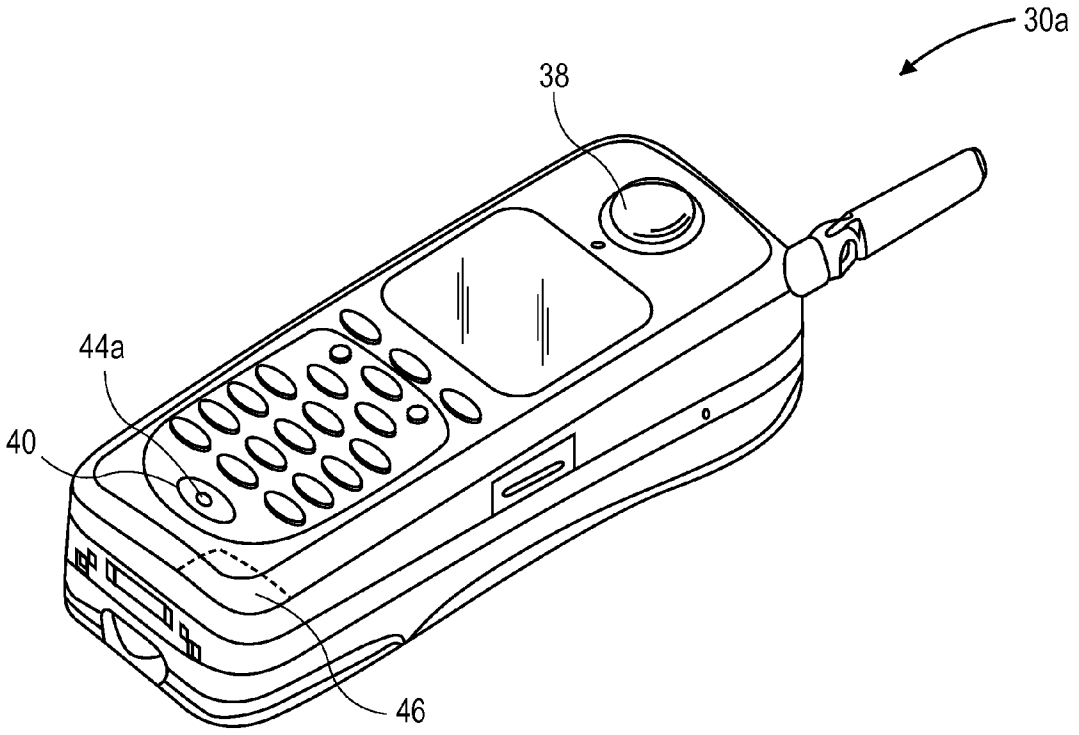


FIG. 3

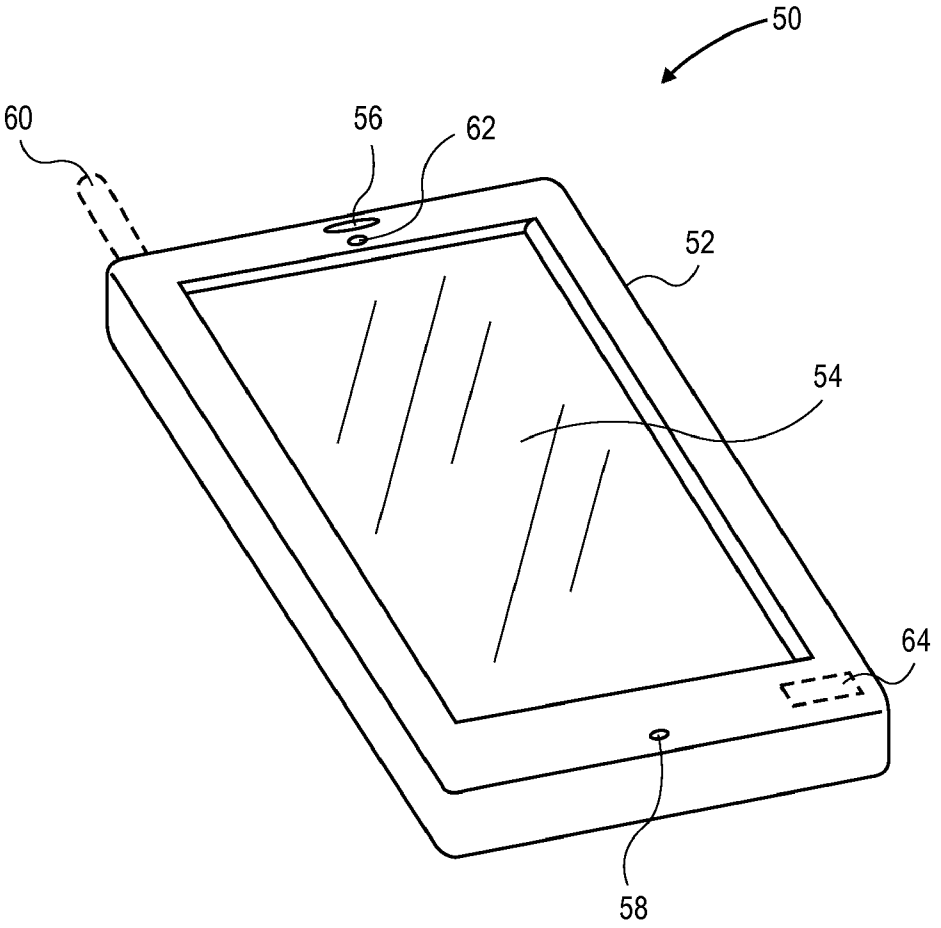


FIG. 4

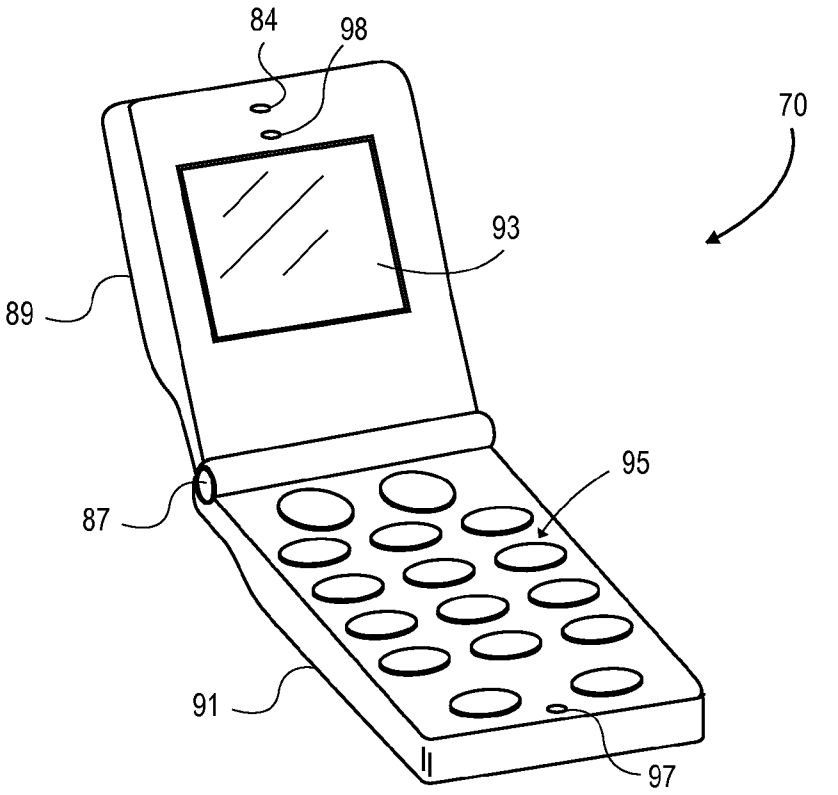


FIG. 5A

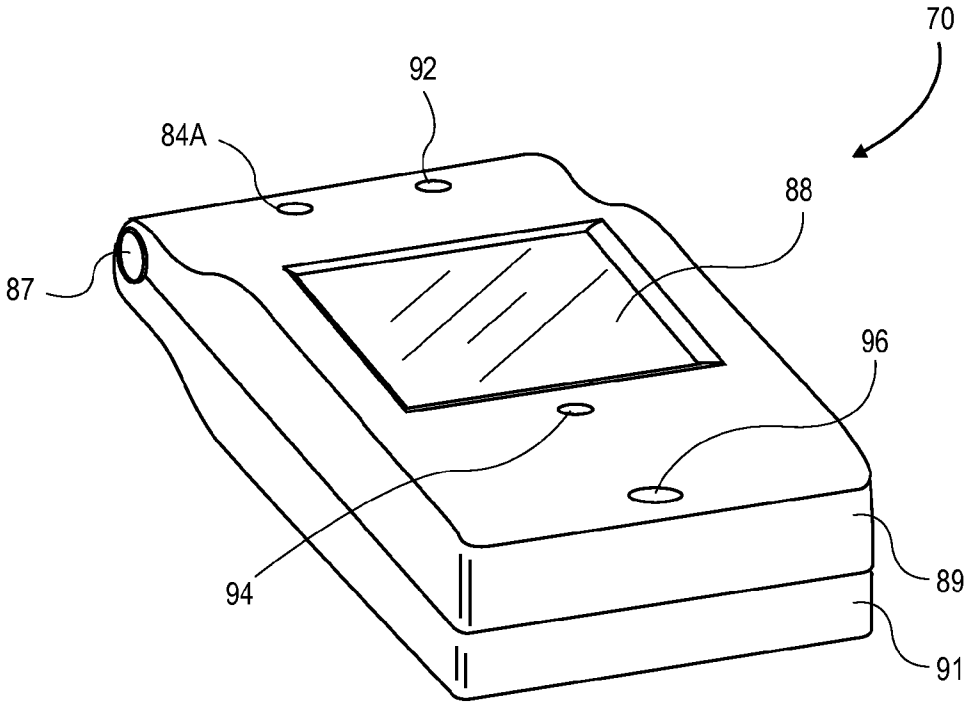


FIG. 5B

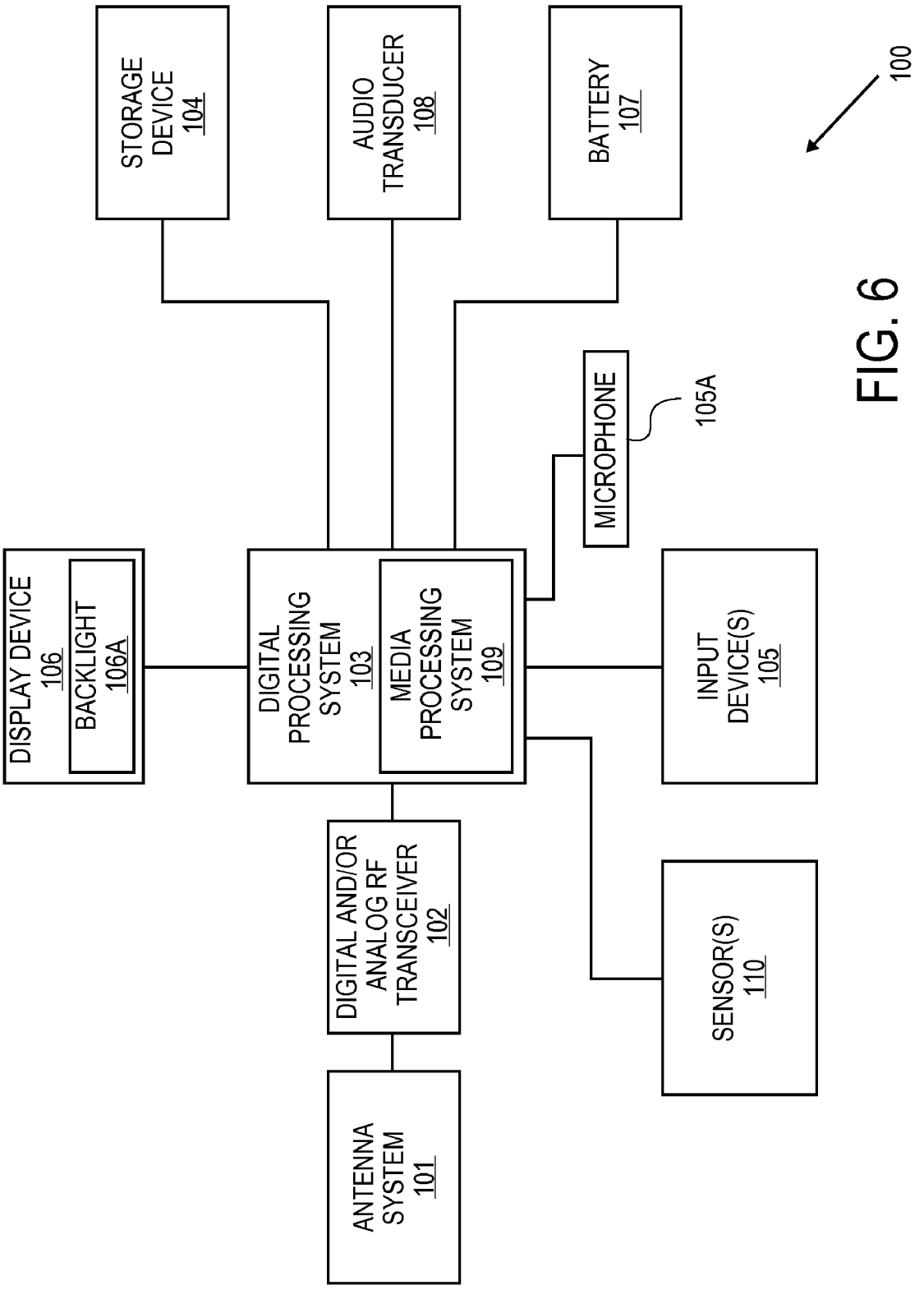

STORAGE DEVICE 104
AUDIO TRANSDUCER 108
BATTERY 107
100
MICROPHONE
105A
DISPLAY DEVICE 106
BACKLIGHT 106A
DIGITAL PROCESSING SYSTEM 103
MEDIA PROCESSING SYSTEM 109
INPUT DEVICE(S) 105
DIGITAL AND/OR ANALOG RF TRANSCEIVER 102
SENSOR(S) 110
ANTENNA SYSTEM 101

FIG. 6

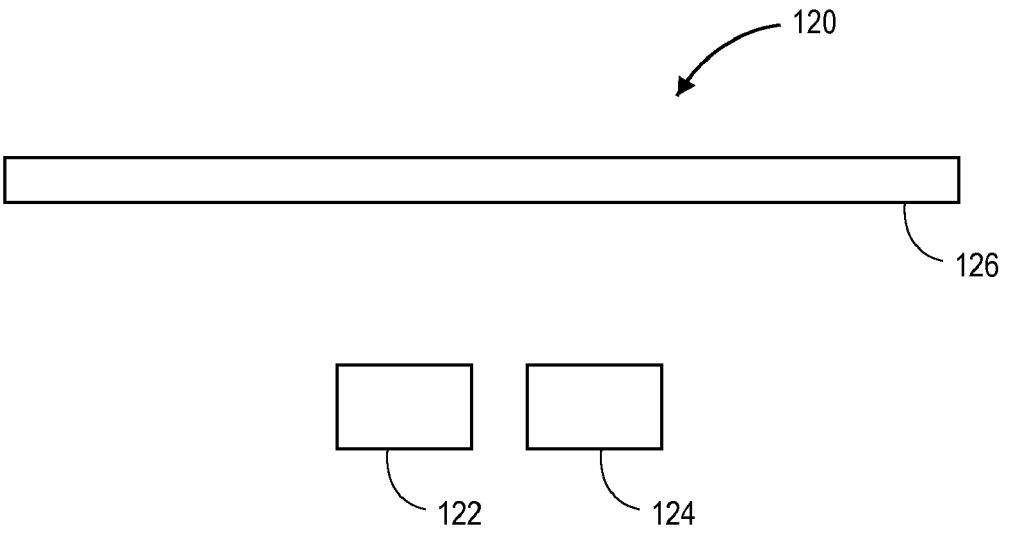


FIG. 7A

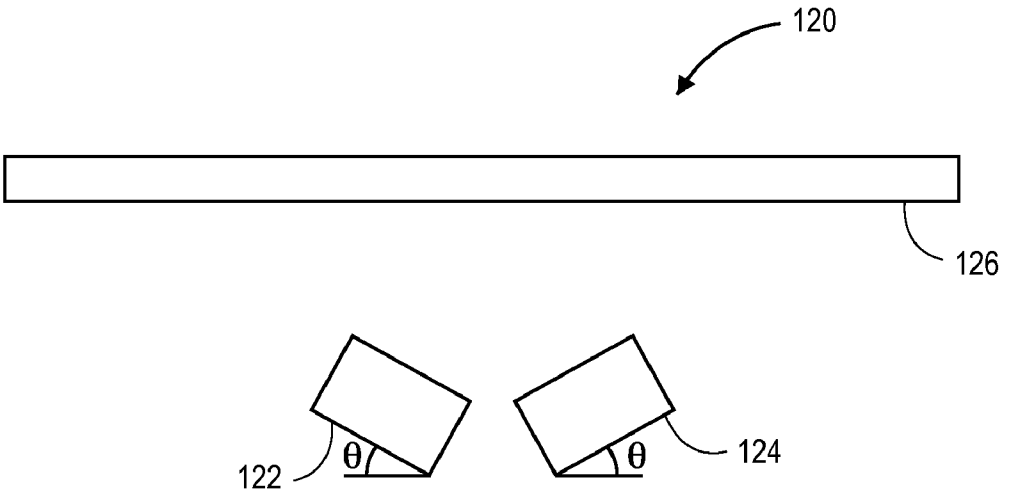
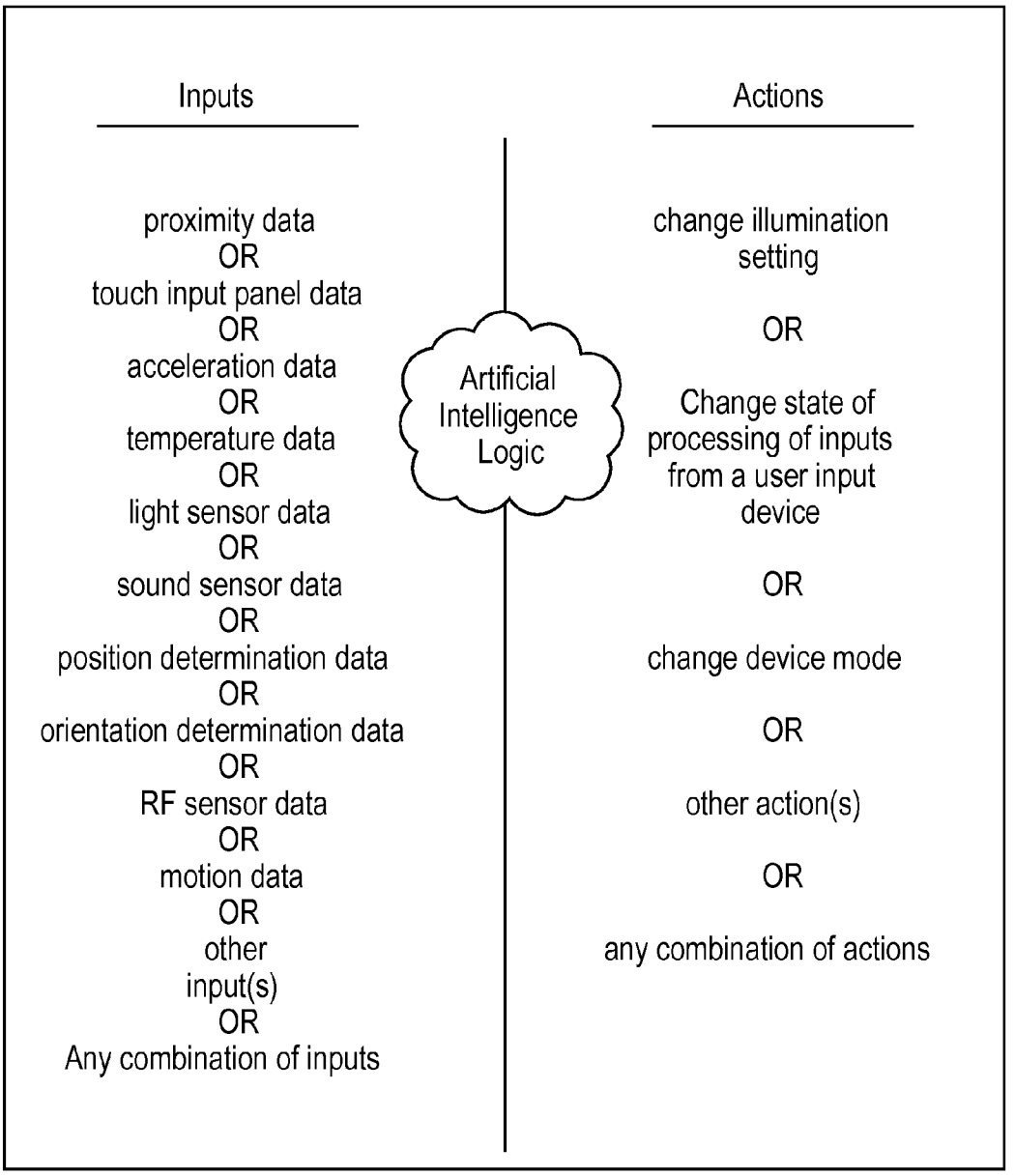


FIG. 7B

FIG. 8


Inputs
proximity data
OR
touch input panel data
OR
acceleration data
OR
temperature data
OR
light sensor data
OR
sound sensor data
OR
position determination data
OR
orientation determination data
OR
RF sensor data
OR
motion data
OR
other
input(s)
OR
Any combination of inputs
Artificial Intelligence Logic
Actions
change illumination setting
OR
Change state of processing of inputs from a user input device
OR
change device mode
OR
other action(s)
OR
any combination of actions

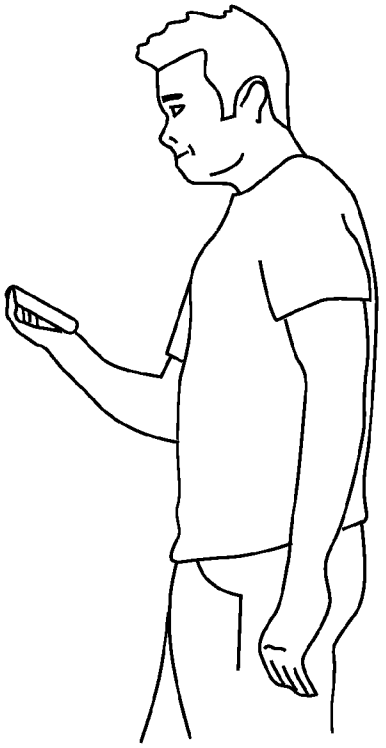


FIG. 9A

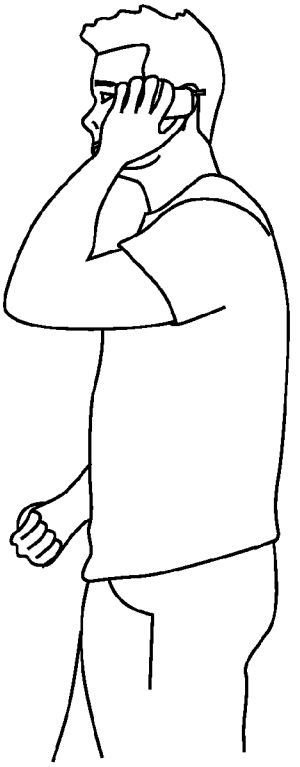


FIG. 9B

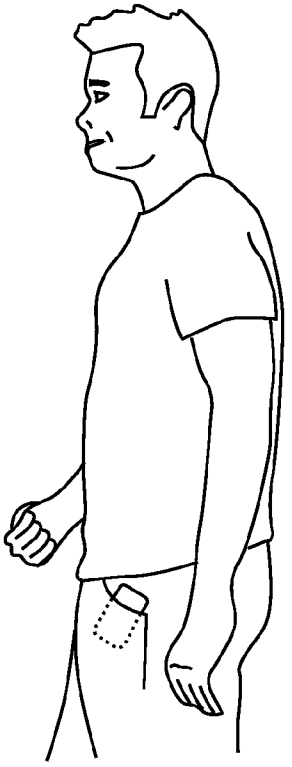


FIG. 9C

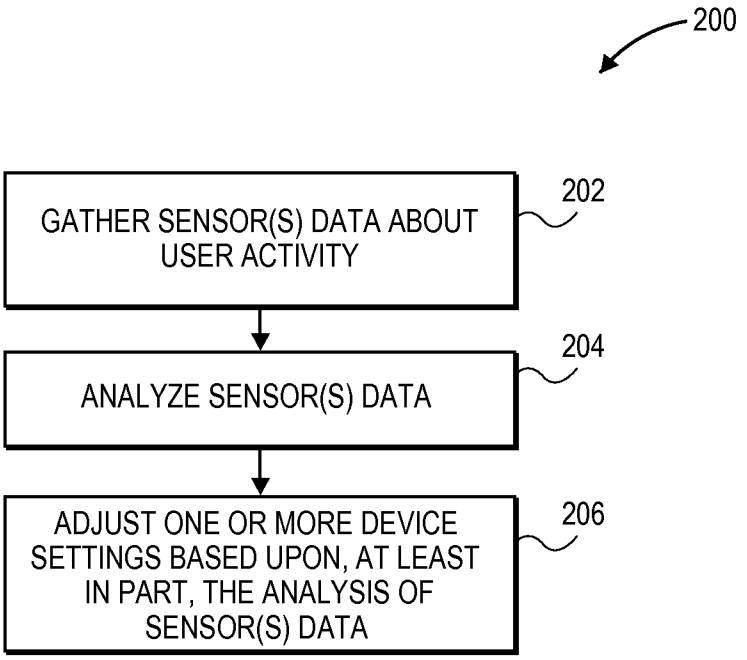

200
GATHER SENSOR(S) DATA ABOUT USER ACTIVITY
202
ANALYZE SENSOR(S) DATA
204
ADJUST ONE OR MORE DEVICE SETTINGS BASED UPON, AT LEAST IN PART, THE ANALYSIS OF SENSOR(S) DATA
206

FIG. 10

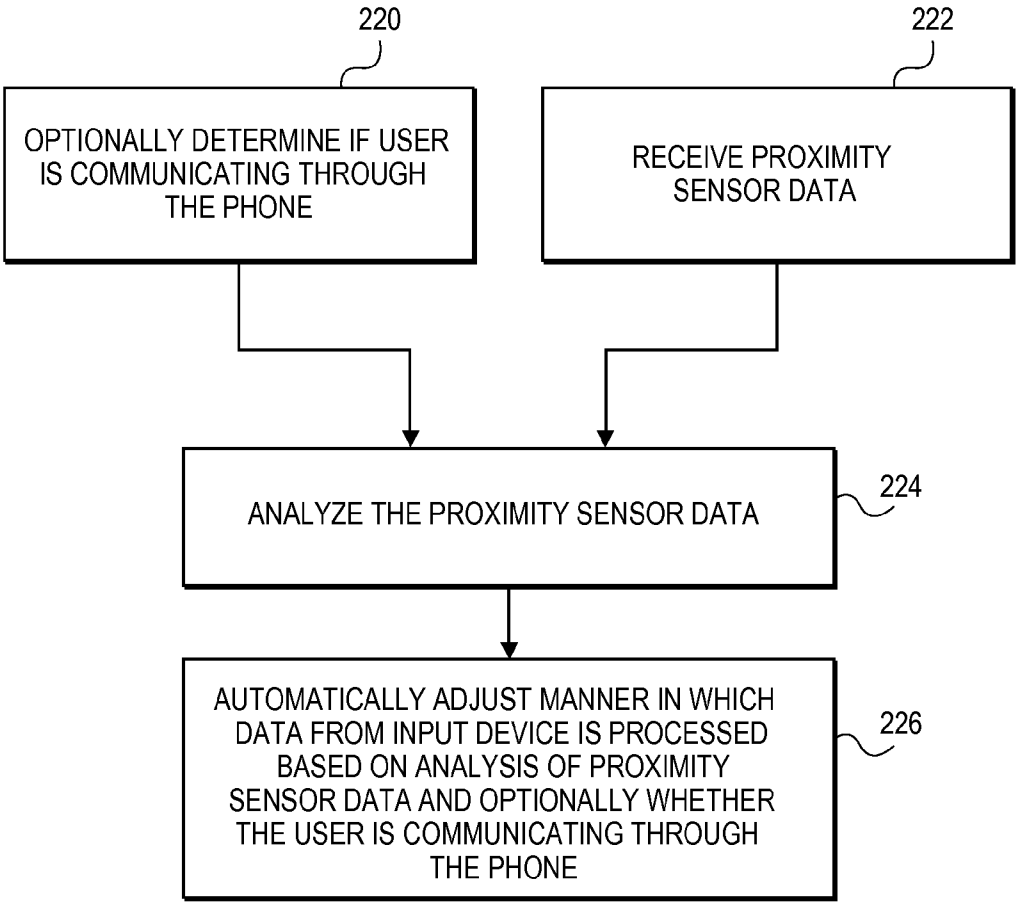

220
222
OPTIONALLY DETERMINE IF USER IS COMMUNICATING THROUGH THE PHONE
RECEIVE PROXIMITY SENSOR DATA
ANALYZE THE PROXIMITY SENSOR DATA
224
AUTOMATICALLY ADJUST MANNER IN WHICH DATA FROM INPUT DEVICE IS PROCESSED BASED ON ANALYSIS OF PROXIMITY SENSOR DATA AND OPTIONALLY WHETHER THE USER IS COMMUNICATING THROUGH THE PHONE
226

FIG. 11A

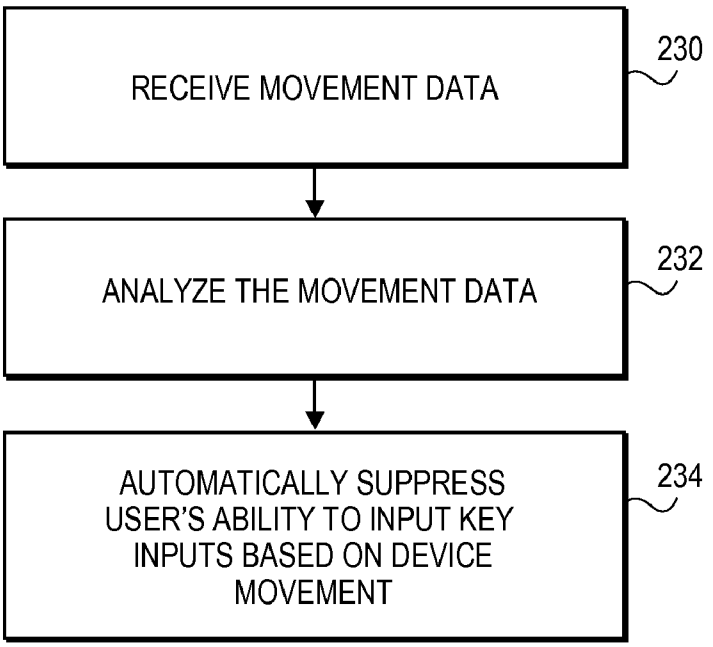

RECEIVE MOVEMENT DATA
230
ANALYZE THE MOVEMENT DATA
232
AUTOMATICALLY SUPPRESS USER'S ABILITY TO INPUT KEY INPUTS BASED ON DEVICE MOVEMENT
234

FIG. 11B

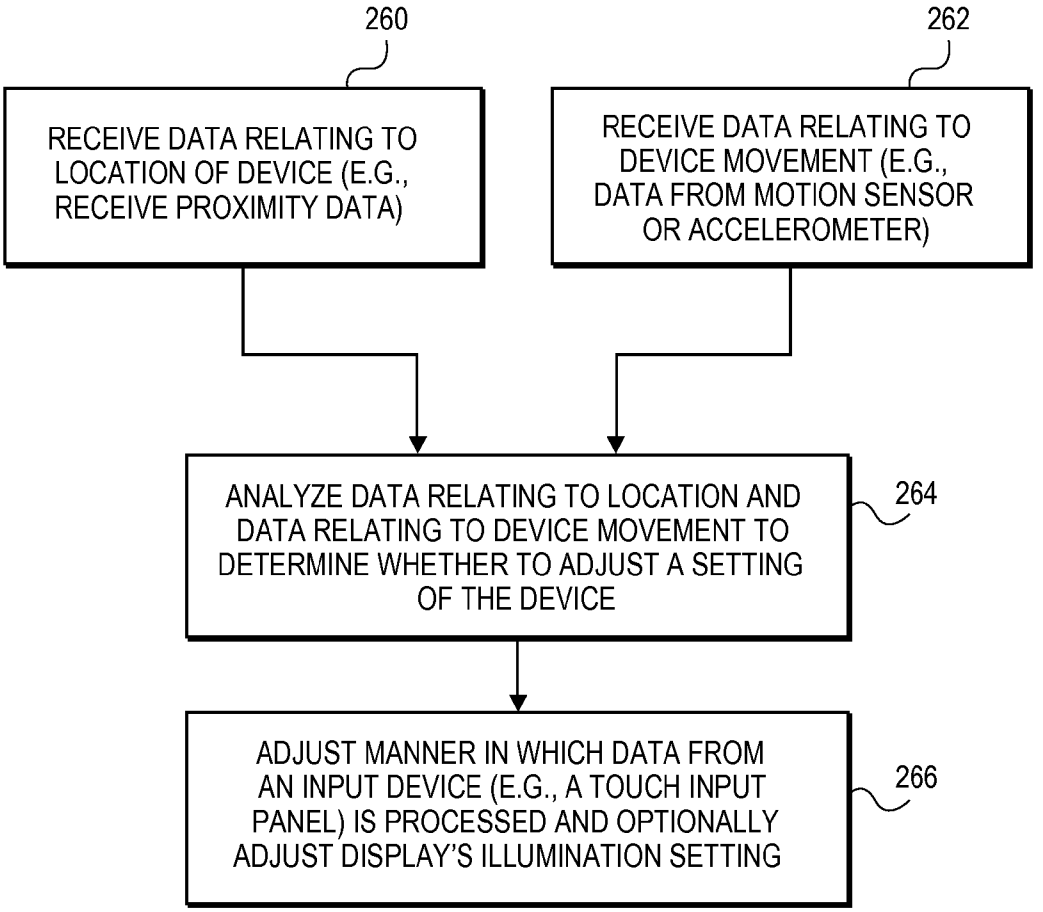

260
262
RECEIVE DATA RELATING TO LOCATION OF DEVICE (E.G., RECEIVE PROXIMITY DATA)
RECEIVE DATA RELATING TO DEVICE MOVEMENT (E.G., DATA FROM MOTION SENSOR OR ACCELEROMETER)
ANALYZE DATA RELATING TO LOCATION AND DATA RELATING TO DEVICE MOVEMENT TO DETERMINE WHETHER TO ADJUST A SETTING OF THE DEVICE
264
ADJUST MANNER IN WHICH DATA FROM AN INPUT DEVICE (E.G., A TOUCH INPUT PANEL) IS PROCESSED AND OPTIONALLY ADJUST DISPLAY'S ILLUMINATION SETTING
266

FIG. 11C

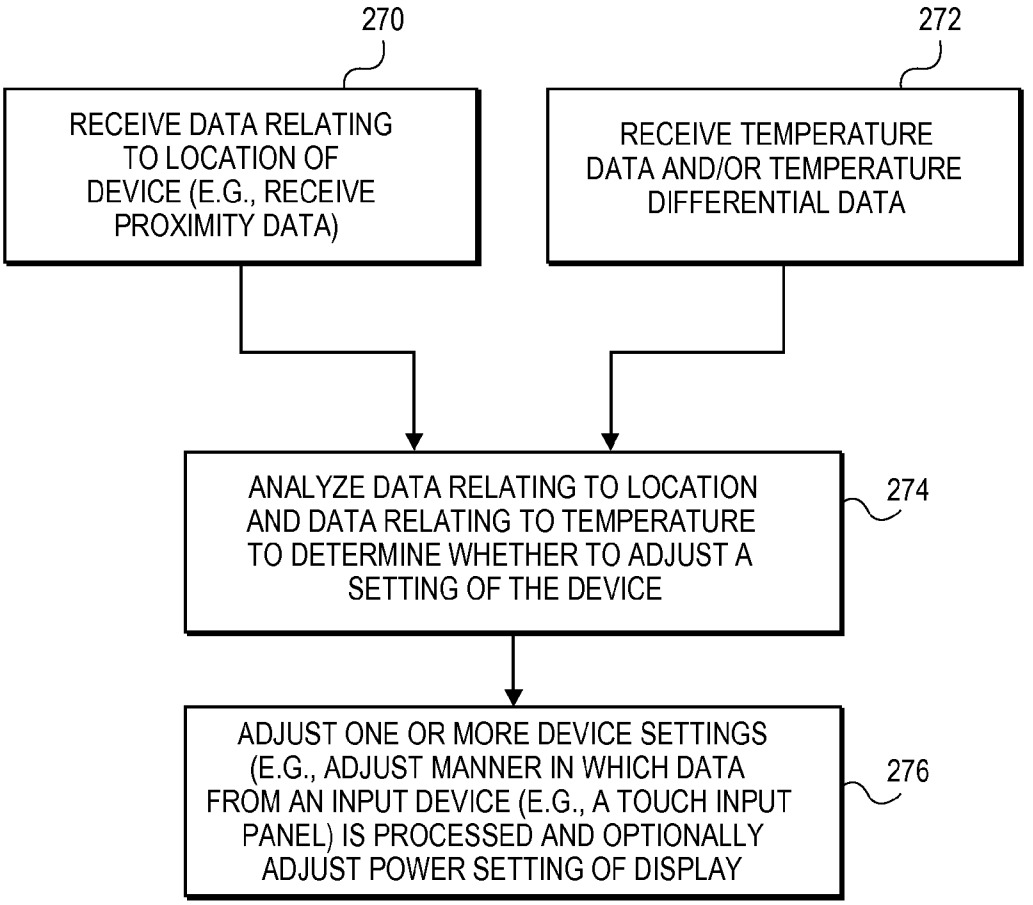

270
272
RECEIVE DATA RELATING TO LOCATION OF DEVICE (E.G., RECEIVE PROXIMITY DATA)
RECEIVE TEMPERATURE DATA AND/OR TEMPERATURE DIFFERENTIAL DATA
ANALYZE DATA RELATING TO LOCATION AND DATA RELATING TO TEMPERATURE TO DETERMINE WHETHER TO ADJUST A SETTING OF THE DEVICE
274
ADJUST ONE OR MORE DEVICE SETTINGS (E.G., ADJUST MANNER IN WHICH DATA FROM AN INPUT DEVICE (E.G., A TOUCH INPUT PANEL) IS PROCESSED AND OPTIONALLY ADJUST POWER SETTING OF DISPLAY
276

FIG. 11D

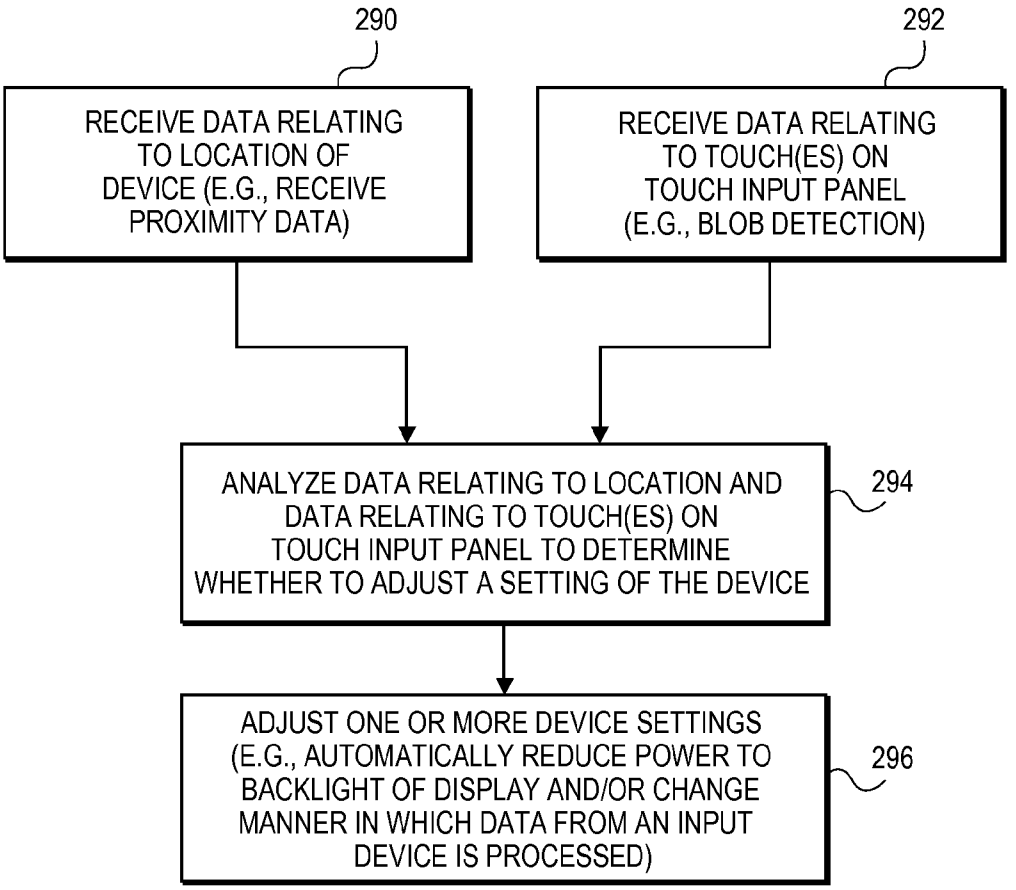

290
292
RECEIVE DATA RELATING TO LOCATION OF DEVICE (E.G., RECEIVE PROXIMITY DATA)
RECEIVE DATA RELATING TO TOUCH(ES) ON TOUCH INPUT PANEL (E.G., BLOB DETECTION)
ANALYZE DATA RELATING TO LOCATION AND DATA RELATING TO TOUCH(ES) ON TOUCH INPUT PANEL TO DETERMINE WHETHER TO ADJUST A SETTING OF THE DEVICE
294
ADJUST ONE OR MORE DEVICE SETTINGS (E.G., AUTOMATICALLY REDUCE POWER TO BACKLIGHT OF DISPLAY AND/OR CHANGE MANNER IN WHICH DATA FROM AN INPUT DEVICE IS PROCESSED)
296

FIG. 11E

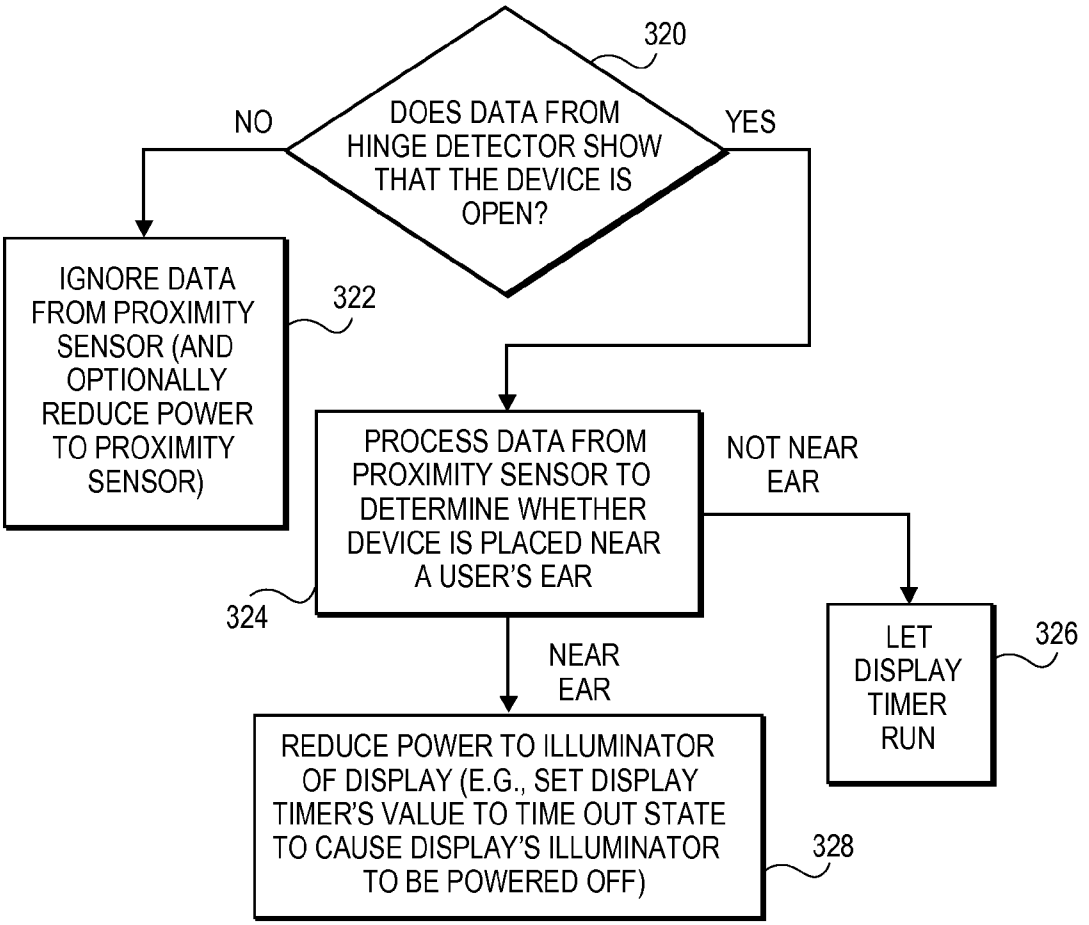

320
DOES DATA FROM HINGE DETECTOR SHOW THAT THE DEVICE IS OPEN?
NO
YES
IGNORE DATA FROM PROXIMITY SENSOR (AND OPTIONALLY REDUCE POWER TO PROXIMITY SENSOR)
322
PROCESS DATA FROM PROXIMITY SENSOR TO DETERMINE WHETHER DEVICE IS PLACED NEAR A USER'S EAR
324
NOT NEAR EAR
NEAR EAR
LET DISPLAY TIMER RUN
326
REDUCE POWER TO ILLUMINATOR OF DISPLAY (E.G., SET DISPLAY TIMER'S VALUE TO TIME OUT STATE TO CAUSE DISPLAY'S ILLUMINATOR TO BE POWERED OFF)
328

FIG. 11F

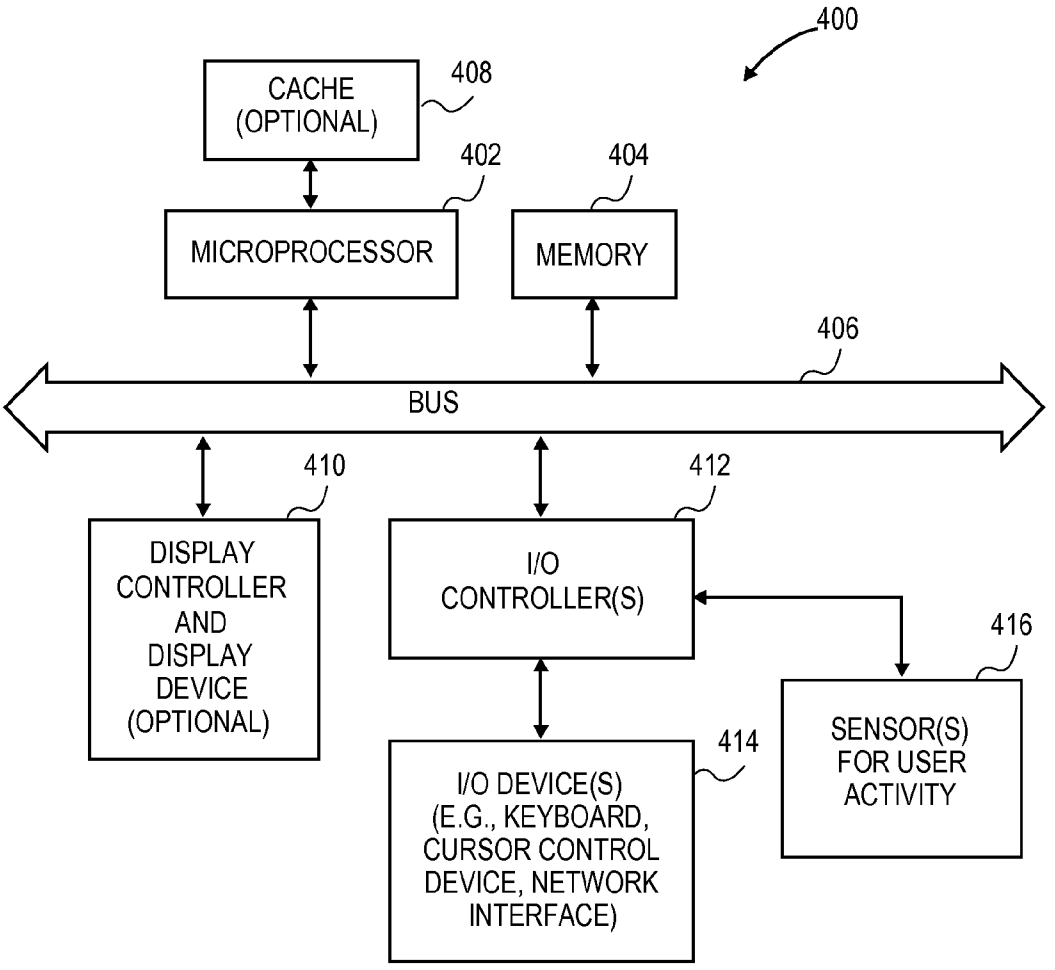

400
CACHE (OPTIONAL)
408
402
404
MICROPROCESSOR
MEMORY
406
BUS
410
412
DISPLAY CONTROLLER AND DISPLAY DEVICE (OPTIONAL)
I/O CONTROLLER(S)
416
SENSOR(S) FOR USER ACTIVITY
414
I/O DEVICE(S) (E.G., KEYBOARD, CURSOR CONTROL DEVICE, NETWORK INTERFACE)

FIG. 12

AUTOMATED RESPONSE TO AND SENSING OF USER ACTIVITY IN PORTABLE DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-in-Part of U.S. patent application Ser. No. 11/241,839, filed Sep. 30, 2005, titled "PROXIMITY DETECTOR IN HANDHELD DEVICE" and U.S. patent application Ser. No. 11/240,788, filed Sep. 30, 2005, titled "PROXIMITY DETECTOR IN HANDHELD DEVICE" which are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

This invention relates to the field of portable devices and, in particular, to systems and methods for sensing or determining user activities and responding to the user's activities.

BACKGROUND OF THE INVENTION

Portable devices, such as cell phones, are becoming increasingly common. These portable devices have grown more complex over time, incorporating many features including, for example, MP3 player capabilities, web browsing capabilities, capabilities of personal digital assistants (PDAs) and the like.

The battery life of these portable devices, however, can be limited. Often, the primary draw of battery power is the display device for these portable devices and, in particular, the backlight, which can be used to illuminate the display device. In many current portable devices, an exemplary process **10** for illuminating the display is shown in FIG. **1**. In this process, the backlight is activated (e.g. turned on to generate light) when a user enters a key input into the portable device as shown in operation **12**. A timer is started at operation **14** in response to activating the backlight, and the portable device determines, at operation **16**, whether a time out of the timer has occurred. If the portable device receives a user key input at operation **18**, the timer restarts (in operation **14**) and the process continues as described above. If the portable device does not receive a user input while the timer is counting, the time out will occur, and the backlight is deactivated at operation **20**.

In addition, users often inadvertently enter key inputs on the input device of the portable device, which can result in the telephone performing operations which the user did not intend. For example, the backlight may illuminate, a telephone number may be dialed, a ring setting may be changed, etc., because the user accidentally contacts a key on the input device. The inadvertent entry of an input is particularly troublesome for a touch screen device, especially one which may receive an inadvertent input when a user has the portable device placed next to the user's ear.

SUMMARY OF THE DESCRIPTION

The various methods and devices described herein relate to devices which, in at least certain embodiments, may include one or more sensors, such as a proximity sensor, for providing data relating to user activity and at least one processor for causing the device to respond based on the user activity which was determined, at least in part, through the sensors. The response by the device may include a change of state of the device, and the response may be automatically performed after the user activity is determined.

According to one embodiment of the inventions, a method includes receiving data from at least one sensor, such as a proximity sensor, at a device, analyzing the data to determine activity of a user of the device, and modifying, in response to the analyzing, at least one setting of the device such as a setting relating to how input data from an input device is processed. The device may be a telephone, such as a cell phone, or an integrated telephone and media player, or other types of devices which can include the sensor and logic to process data from the sensor and the input device may be a keypad or a multi-touch input panel. The sensors may be any one of a variety of sensors including, for example, a proximity sensor, a temperature sensor, an accelerometer, a light sensor, a position determination device, an orientation determination device, a radio frequency electromagnetic wave sensor, a touch input panel, a motion sensor, or a sound sensor. In certain embodiments, the device may include a plurality of sensors which together provide data to at least one processor which analyzes the data to determine activity of the user. In at least certain embodiments, the analyzing may use an artificial intelligence process which includes a comparison of data, derived from the one or more sensors, to a threshold; for example, the data from a proximity sensor may be compared to a threshold value which represents a distance between a portion of the device and the user's ear or head. The data from a sensor may represent an analog value detected by the sensor; the analog value may indicate any one of a variety of analog values including, for example, a distance, a temperature, a light intensity, a measurement of motion or orientation, a measurement of sound intensity or an RF electromagnetic measurement. The artificial intelligence process, in at least certain embodiments, may be required to receive the data and to select an interpretation of the data from a set of possible interpretations, and the interpretation which is selected will in turn be used to decide how to modify the at least one setting. The setting which is modified may be any one of a variety of settings including, for example, a setting of a display illuminator, a setting of a sound input or sound output parameter, a setting of a state of an input device relative to receipt of user input, a setting of a communication parameter, a setting of a processor, or a setting of the mode of the device (e.g. cell phone mode or media player mode).

Various devices which perform one or more of the foregoing methods and machine readable media which, when executed by a processing system, cause the processing system to perform these methods, are also described.

According to another embodiment of the inventions, a method of operating a portable device having a hinge includes sensing a state of the hinge, analyzing data from a proximity sensor when the state of the hinge shows that the portable device is in an open configuration, and modifying at least one setting of the portable device in response to the analyzing. In at least certain embodiments, when the state of the hinge indicates that the portable device is in a closed configuration, the data from the proximity sensor is either ignored or not processed to determine whether a user's head or ear is near the proximity sensor; further, when in this closed configuration, the proximity sensor is placed in a reduced power consumption state. An implementation of one or more of these methods may be performed by a cellular telephone which typically includes a first housing, a second housing, a hinge which couples the first housing to the second housing, a hinge state detector to detect a state of the hinge, a proximity sensor, and at least one processor coupled to the proximity sensor and to the hinge state detector.

Other methods, devices and machine readable media are also described.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described by way of example with reference to the accompanying drawings, wherein:

FIG. **1** is flow chart of a prior art method for responding to user input and controlling the backlight of a display in response to the user input;

FIG. **2** is a perspective view of a portable device in accordance with one embodiment of the present invention;

FIG. **3** is a perspective view of a portable device in accordance with one embodiment of the present invention;

FIG. **4** is a perspective view of a portable device in accordance with one embodiment of the present invention;

FIG. **5**A is a perspective view of a portable device in a first configuration (e.g. in an open configuration) in accordance with one embodiment of the present invention;

FIG. **5**B is a perspective view of the portable device of FIG. **5**A in a second configuration (e.g. a closed configuration) in accordance with one embodiment of the present invention;

FIG. **6** is a block diagram of a system in which embodiments of the present invention can be implemented;

FIG. **7**A is a schematic side view of a proximity sensor in accordance with one embodiment of the present invention;

FIG. **7**B is a schematic side view of an alternative proximity sensor in accordance with one embodiment of the present invention;

FIG. **8** is a block diagram of inputs and outputs for logic, such as artificial intelligence logic, in accordance with embodiments of the present invention;

FIGS. **9**A-C are views of user activities in accordance with embodiments of the present invention;

FIG. **10** is a flow chart of a method that includes automated responses to user activity in accordance with embodiments of the present invention;

FIGS. **11**A-F are flow charts of combinations of sensing to determine user activity and performing automated responses in accordance with embodiments of the present invention; and

FIG. **12** is a block diagram of a digital processing system in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

Various embodiments and aspects of the inventions will be described with reference to details discussed below, and the accompanying drawings will illustrate the various embodiments. The following description and drawings are illustrative of the invention and are not to be construed as limiting the invention. Numerous specific details are described to provide a through understanding of various embodiments of the present invention. However, in certain instances, well-known or conventional details are not described in order to provide a concise discussion of embodiments of the present inventions.

Some portions of the detailed descriptions which follow are presented in terms of algorithms which include operations on data stored within a computer memory. An algorithm is generally a self-consistent sequence of operations leading to a desired result. The operations typically require or involve physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like, can refer to the action and processes of a data processing system, or similar electronic device, that manipulates and transforms data represented as physical (electronic) quantities within the system's registers and memories into other data similarly represented as physical quantities within the system's memories or registers or other such information storage, transmission or display devices.

The present invention can relate to an apparatus for performing one or more of the operations described herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a machine (e.g. computer) readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), erasable programmable ROMs (EPROMs), electrically erasable programmable ROMs (EEPROMs), magnetic or optical cards, or any type of media suitable for storing electronic instructions, and each coupled to a bus.

A machine-readable medium includes any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computer). For example, a machine-readable medium includes read only memory ("ROM"); random access memory ("RAM"); magnetic disk storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.); etc.

At least certain embodiments of the present inventions include one or more sensors to monitor user activity. At least certain embodiments of the present inventions also include automatically changing a state of the portable device based on user activity, such as, for example, automatically activating or deactivating a backlight of a display device of the portable device or setting an input device of the portable device to a particular state, based on certain predetermined user activities.

At least certain embodiments of the inventions may be part of a digital media player, such as a portable music and/or video media player, which may include a media processing system to present the media, a storage device to store the media and may further include a radio frequency (RF) transceiver (e.g., an RF transceiver for a cellular telephone) coupled with an antenna system and the media processing system. In certain embodiments, media stored on a remote storage device may be transmitted to the media player through the RF transceiver. The media may be, for example, one or more of music or other audio, still pictures, or motion pictures.

The portable media player may include a media selection device, such as a click wheel input device on an iPod® or iPod Nano® media player from Apple Computer, Inc. of Cupertino, Calif., a touch screen input device, pushbutton device, movable pointing input device or other input device. The media selection device may be used to select the media stored on the storage device and/or the remote storage device. The portable media player may, in at least certain embodiments, include a display device which is coupled to the media processing system to display titles or other indicators of media being selected through the input device and being presented,

either through a speaker or earphone(s), or on the display device, or on both display device and a speaker or earphone (s). Examples of a portable media player are described in published U.S. patent application numbers 2003/0095096 and 2004/0224638, both of which are incorporated herein by reference.

Embodiments of the inventions described herein may be part of other types of data processing systems, such as, for example, entertainment systems or personal digital assistants (PDAs), or general purpose computer systems, or special purpose computer systems, or an embedded device within another device, or cellular telephones which do not include media players, or devices which combine aspects or functions of these devices (e.g., a media player, such as an iPod®, combined with a PDA, an entertainment system, and a cellular telephone in one portable device).

FIG. **2** illustrates a portable device **30** according to one embodiment of the invention. FIG. **2** shows a wireless device in a telephone configuration having a "candy-bar" style. In FIG. **2**, the wireless device **30** may include a housing **32**, a display device **34**, an input device **36** which may be an alphanumeric keypad, a speaker **38**, a microphone **40** and an antenna **42**. The wireless device **30** also may include a proximity sensor **44** and an accelerometer **46**. It will be appreciated that the embodiment of FIG. **2** may use more or fewer sensors and may have a different form factor from the form factor shown in FIG. **2**.

The display device **34** is shown positioned at an upper portion of the housing **32**, and the input device **36** is shown positioned at a lower portion of the housing **32**. The antenna **42** is shown extending from the housing **32** at an upper portion of the housing **32**. The speaker **38** is also shown at an upper portion of the housing **32** above the display device **34**. The microphone **40** is shown at a lower portion of the housing **32**, below the input device **36**. It will be appreciated that the speaker **38** and microphone **40** can be positioned at any location on the housing, but are typically positioned in accordance with a user's ear and mouth, respectively. The proximity sensor **44** is shown at or near the speaker **38** and at least partially within the housing **32**. The accelerometer **46** is shown at a lower portion of the housing **32** and within the housing **32**. It will be appreciated that the particular locations of the above-described features may vary in alternative embodiments.

The display device **34** may be, for example, a liquid crystal display (LCD) which does not include the ability to accept inputs or a touch input screen which also includes an LCD. The input device **36** may include, for example, buttons, switches, dials, sliders, keys or keypad, navigation pad, touch pad, touch screen, and the like.

Any well-known speaker, microphone and antenna can be used for speaker **38**, microphone **40** and antenna **42**, respectively.

The proximity sensor **44** may detect location (e.g. X, Y, Z), direction, speed, orientation (e.g., roll, pitch, yaw), etc. of objects relative to the wireless device **30**. A location of an object relative to the wireless device can be represented as a distance in at least certain embodiments. The proximity sensor may generate location or movement data or both, which may be used to determine the location of objects relative to the portable device **30** and/or proximity sensor **44**. An example of a proximity sensor is shown in FIG. **7**A.

In addition, a processing device (not shown) is coupled to the proximity sensor(s) **44**. The processing device may be used to determine the location of objects relative to the portable device **30** or proximity sensor **44** or both based on the location and/or movement data provided by the proximity sensor **44**. The proximity sensor may continuously or periodically monitor the object location. The proximity sensor may also be able to determine the type of object it is detecting.

Additional information about proximity sensors can be found in U.S. patent application Ser. No. 11/241,839, titled "PROXIMITY DETECTOR IN HANDHELD DEVICE," and U.S. patent application Ser. No. 11/240,788, titled "PROXIMITY DETECTOR IN HANDHELD DEVICE;" U.S. patent application Ser. No. 11/165,958, titled "METHODS AND APPARATUS FOR REMOTELY DETECTING PRESENCE," filed Jun. 23, 2005; and U.S. Pat. No. 6,583,676, titled "PROXIMITY/TOUCH DETECTOR AND CALIBRATION CIRCUIT," issued Jun. 24, 2003, all of which are incorporated herein by reference in their entirety.

According to one embodiment, the accelerometer **46** is able to detect a movement including an acceleration or deacceleration of the wireless device. The accelerometer **46** may generate movement data for multiple dimensions, which may be used to determine a direction of movement of the wireless device. For example, the accelerometer **46** may generate X, Y and Z axis acceleration information when the accelerometer **46** detects that the portable device is moved. In one embodiment, the accelerometer **46** may be implemented as described in U.S. Pat. No. 6,520,013, which is incorporated herein by reference in its entirety. Alternatively, the accelerometer **46** may be a KGF01 accelerometer from Kionix or an ADXL311 accelerometer from Analog Devices or other accelerometers which are known in the art.

In addition, a processing device (not shown) is coupled to the accelerometer(s) **46**. The processing device may be used to calculate a direction of movement, also referred to as a movement vector of the wireless device **30**. The movement vector may be determined according to one or more predetermined formulas based on the movement data (e.g., movement in X, Y and Z) provided by accelerometer **46**. The processing device may be integrated with the accelerometer **46** or integrated with other components, such as, for example, a chipset of a microprocessor, of the portable device.

The accelerometer **46** may continuously or periodically monitor the movement of the portable device. As a result, an orientation of the portable device prior to the movement and after the movement may be determined based on the movement data provided by the accelerometer attached to the portable device.

Additional information about accelerometers can be found in copending U.S. patent application Ser. No. 10/986,730, filed Nov. 12, 2004, which is hereby incorporated herein by reference in its entirety.

The data acquired from the proximity sensor **44** and the accelerometer **46** can be combined together, or used alone, to gather information about the user's activities. The data from the proximity sensor **44**, the accelerometer **46** or both can be used, for example, to activate/deactivate a display backlight, initiate commands, make selections, control scrolling or other movement in a display, control input device settings, or to make other changes to one or more settings of the device.

FIG. **3** shows an alternative portable device **30***a*, which is similar to the portable device **30** illustrated in FIG. **2**. The portable device **30***a* shown in FIG. **3** can differ from the portable device **30** shown in FIG. **2** in that the proximity sensor **44***a* (FIG. **3**) is located at or near the microphone **40**.

FIG. **4** shows a portable device **50** in accordance with one embodiment of the invention. The portable device **50** may include a housing **52**, a display/input device **54**, a speaker **56**, a microphone **58** and an optional antenna **60** (which may be visible on the exterior of the housing or may be concealed within the housing). The portable device **50** also may include

a proximity sensor **62** and an accelerometer **64**. The portable device **50** may be a cellular telephone or a device which is an integrated PDA and a cellular telephone or a device which is an integrated media player and a cellular telephone or a device which is both an entertainment system (e.g. for playing games) and a cellular telephone, or the portable device **50** may be other types of devices described herein. In one particular embodiment, the portable device **50** may include a cellular telephone and a media player and a PDA, all contained within the housing **52**. The portable device **50** may have a form factor which is small enough that it fits within the hand of a normal adult and is light enough that it can be carried in one hand by an adult. It will be appreciated that the term "portable" means the device can be easily held in an adult user's hands (one or both); for example, a laptop computer and an iPod are portable devices.

In one embodiment, the display/input device **54** may include a multi-point touch input screen in addition to being a display, such as an LCD. In one embodiment, the multi-point touch screen is a capacitive sensing medium configured to detect multiple touches (e.g., blobs on the display from a user's face or multiple fingers concurrently touching or nearly touching the display) or near touches (e.g., blobs on the display) that occur at the same time and at distinct locations in the plane of the touch panel and to produce distinct signals representative of the location of the touches on the plane of the touch panel for each of the multiple touches. Additional information about multi-point input touch screens can be found in copending U.S. patent application Ser. No. 10/840,862, filed May 6, 2004 (see published U.S. patent application 20060097991), which is incorporated herein by reference in its entirety. A multi-point input touch screen may also be referred to as a multi-touch input panel.

A processing device (not shown) may be coupled to the display/input device **54**. The processing device may be used to calculate touches on the touch panel. The display/input device **54** can use the detected touch (e.g., blob or blobs from a user's face) data to, for example, identify the location of certain objects and to also identify the type of object touching (or nearly touching) the display/input device **54**.

The data acquired from the proximity sensor **62** and the display/input device **54** can be combined to gather information about the user's activities as described herein. The data from the proximity sensor **62** and the display/input device **54** can be used to change one or more settings of the portable device **50**, such as, for example, change an illumination setting of the display/input device **54**.

In one embodiment, as shown in FIG. **4**, the display/input device **54** occupies a large portion of one surface (e.g. the top surface) of the housing **52** of the portable device **50**. In one embodiment, the display/input device **54** consumes substantially the entire front surface of the portable device **50**. In another embodiment, the display/input device **54** consumes, for example, at least 75% of a front surface of the housing **52** of the portable device **50**. In alternative embodiments, the portable device **50** may include a display which does not have input capabilities, but the display still occupies a large portion of one surface of the portable device **50**. In this case, the portable device **50** may include other types of input devices such as a QWERTY keyboard or other types of keyboard which slide out or swing out from a portion of the portable device **50**.

FIGS. **5**A and **5**B illustrate a portable device **70** according to one embodiment of the invention. The portable device **70** may be a cellular telephone which includes a hinge **87** that couples a display housing **89** to a keypad housing **91**. The hinge **87** allows a user to open and close the cellular telephone so that it can be placed in at least one of two different configurations shown in FIGS. **5**A and **5**B. In one particular embodiment, the hinge **87** may rotatably couple the display housing to the keypad housing. In particular, a user can open the cellular telephone to place it in the open configuration shown in FIG. **5**A and can close the cellular telephone to place it in the closed configuration shown in FIG. **5**B. The keypad housing **91** may include a keypad **95** which receives inputs (e.g. telephone number inputs or other alphanumeric inputs) from a user and a microphone **97** which receives voice input from the user. The display housing **89** may include, on its interior surface, a display **93** (e.g. an LCD) and a speaker **98** and a proximity sensor **84**; on its exterior surface, the display housing **89** may include a speaker **96**, a temperature sensor **94**, a display **88** (e.g. another LCD), an ambient light sensor **92**, and a proximity sensor **84**A. Hence, in this embodiment, the display housing **89** may include a first proximity sensor on its interior surface and a second proximity sensor on its exterior surface. The first proximity sensor may be used to detect a user's head or ear being within a certain distance of the first proximity sensor and to cause an illumination setting of displays **93** and **88** to be changed automatically in response to this detecting (e.g. the illumination for both displays are turned off or otherwise set in a reduced power state). Data from the second proximity sensor, along with data from the ambient light sensor **92** and data from the temperature sensor **94**, may be used to detect that the cellular telephone has been placed into the user's pocket.

In at least certain embodiments, the portable device **70** may contain components which provide one or more of the functions of a wireless communication device such as a cellular telephone, a media player, an entertainment system, a PDA, or other types of devices described herein. In one implementation of an embodiment, the portable device **70** may be a cellular telephone integrated with a media player which plays MP3 files, such as MP3 music files.

Each of the devices shown in FIGS. **2**, **3**, **4**, **5**A and **5**B may be a wireless communication device, such as a cellular telephone, and may include a plurality of components which provide a capability for wireless communication. FIG. **6** shows an embodiment of a wireless device **100** which includes the capability for wireless communication. The wireless device **100** may be included in any one of the devices shown in FIGS. **2**, **3**, **4**, **5**A and **5**B, although alternative embodiments of those devices of FIGS. **2**-**5**B may include more or fewer components than the wireless device **100**.

Wireless device **100** may include an antenna system **101**. Wireless device **100** may also include a digital and/or analog radio frequency (RF) transceiver **102**, coupled to the antenna system **101**, to transmit and/or receive voice, digital data and/or media signals through antenna system **101**.

Wireless device **100** may also include a digital processing system **103** to control the digital RF transceiver and to manage the voice, digital data and/or media signals. Digital processing system **103** may be a general purpose processing device, such as a microprocessor or controller for example. Digital processing system **103** may also be a special purpose processing device, such as an ASIC (application specific integrated circuit), FPGA (field-programmable gate array) or DSP (digital signal processor). Digital processing system **103** may also include other devices, as are known in the art, to interface with other components of wireless device **100**. For example, digital processing system **103** may include analog-to-digital and digital-to-analog converters to interface with other components of wireless device **100**. Digital processing system **103** may include a media processing system **109**,

which may also include a general purpose or special purpose processing device to manage media, such as files of audio data.

Wireless device **100** may also include a storage device **104**, coupled to the digital processing system, to store data and/or operating programs for the wireless device **100**. Storage device **104** may be, for example, any type of solid-state or magnetic memory device.

Wireless device **100** may also include one or more input devices **105**, coupled to the digital processing system **103**, to accept user inputs (e.g., telephone numbers, names, addresses, media selections, etc.) Input device **105** may be, for example, one or more of a keypad, a touchpad, a touch screen, a pointing device in combination with a display device or similar input device.

Wireless device **100** may also include at least one display device **106**, coupled to the digital processing system **103**, to display information such as messages, telephone call information, contact information, pictures, movies and/or titles or other indicators of media being selected via the input device **105**. Display device **106** may be, for example, an LCD display device. In one embodiment, display device **106** and input device **105** may be integrated together in the same device (e.g., a touch screen LCD such as a multi-touch input panel which is integrated with a display device, such as an LCD display device). Examples of a touch input panel and a display integrated together are shown in U.S. published application No. 20060097991. The display device **106** may include a backlight **106***a* to illuminate the display device **106** under certain circumstances. It will be appreciated that the wireless device **100** may include multiple displays.

Wireless device **100** may also include a battery **107** to supply operating power to components of the system including digital RF transceiver **102**, digital processing system **103**, storage device **104**, input device **105**, microphone **105**A, audio transducer **108**, media processing system **109**, sensor (s) **110**, and display device **106**. Battery **107** may be, for example, a rechargeable or non-rechargeable lithium or nickel metal hydride battery.

Wireless device **100** may also include audio transducers **108**, which may include one or more speakers, and at least one microphone **105**A.

Wireless device **100** may also include one or more sensors **110** coupled to the digital processing system **103**. The sensor (s) **110** may include, for example, one or more of a proximity sensor, accelerometer, touch input panel, ambient light sensor, ambient noise sensor, temperature sensor, gyroscope, a hinge detector, a position determination device, an orientation determination device, a motion sensor, a sound sensor, a radio frequency electromagnetic wave sensor, and other types of sensors and combinations thereof. Based on the data acquired by the sensor(s) **110**, various responses may be performed automatically by the digital processing system, such as, for example, activating or deactivating the backlight **106***a*, changing a setting of the input device **105** (e.g. switching between processing or not processing, as an intentional user input, any input data from an input device), and other responses and combinations thereof.

In one embodiment, digital RF transceiver **102**, digital processing system **103** and/or storage device **104** may include one or more integrated circuits disposed on a printed circuit board (PCB).

FIGS. **7**A and **7**B illustrate exemplary proximity sensors in accordance with embodiments of the invention. It will be appreciated that, in alternative embodiments, other types of proximity sensors, such as capacitive sensors or sonar-like sensors, may be used rather than the proximity sensors shown in FIGS. **7**A and **7**B. In FIG. **7**A, the proximity sensor **120** includes an emitter **122**, a detector **124**, and a window **126**. The emitter **122** generates light in the infrared (IR) bands, and may be, for example, a Light Emitting Diode (LED). The detector **124** is configured to detect changes in light intensity and may be, for example, a phototransistor. The window **126** may be formed from translucent or semi-translucent material. In one embodiment, the window **126** is an acoustic mesh, such as, for example, a mesh typically found with a microphone or speaker of the portable device. In other embodiments, the window **126** may be MicroPerf, IR transparent strands wound in a mesh, or a cold mirror.

During operation, the light from the emitter **122** hits an object **128** and scatters when the object is present above the window **126**. The light from the emitter may be emitted in square wave pulses which have a known frequency, thereby allowing the detector **124** to distinguish between ambient light and light from emitter **122** which is reflected by an object, such as the user's head or ear or a material in a user's pocket, back to the detector **124**. At least a portion of the scattered light is reflected towards the detector **124**. The increase in light intensity is detected by the detector **124**, and this is interpreted by a processing system (not shown in FIG. **7**A) to mean an object is present within a short distance of the detector **124**. If no object is present or the object is beyond a certain distance from the detector **124**, an insufficient or smaller amount of the emitted light is reflected back towards the detector **124**, and this is interpreted by the processing system (not shown in FIG. **7**A) to mean that an object is not present or is at a relatively large distance. In each case, the proximity sensor is measuring the intensity of reflected light which is related to the distance between the object which reflects the light and detector **124**.

In one embodiment, the emitter **122** and detector **124** are disposed within the housing of a portable device, as described above with reference to FIGS. **2**-**5**B.

In FIG. **7**B, the emitter **122** and detector **124** of the proximity sensor are angled inward towards one another to improve detection of the reflected light, but the proximity sensor of FIG. **7**B otherwise operates in a manner similar to the proximity sensor of FIG. **7**A.

It will be appreciated that at least some of the sensors which are used with embodiments of the inventions may determine or provide data which represents an analog value. In other words, the data represents a value which can be any one of a set of possible values which can vary continuously or substantially continuously, rather than being discrete values which have quantum, discrete jumps from one value to the next value. Further, the value represented by the data may not be predetermined. For example, in the case of a distance measured by a proximity sensor, the distance is not predetermined, unlike values of keys on a keypad which represent a predetermined value. For example, a proximity sensor may determine or provide data that represents a distance which can vary continuously or nearly continuously in an analog fashion; in the case of such a proximity sensor, the distance may correspond to the intensity of reflected light which originated from the emitter of the proximity sensor. A temperature sensor may determine or provide data that represents a temperature, which is an analog value. A light sensor, such as an ambient light sensor, may determine or provide data that represents a light intensity which is an analog value. A motion sensor, such as an accelerometer, may determine or provide data which represents a measurement of motion (e.g. velocity or acceleration or both). A gyroscope may determine or provide data which represents a measurement of orientation (e.g. amount of pitch or yaw or roll). A sound sensor may deter-

mine or provide data which represents a measurement of sound intensity. For other types of sensors, the data determined or provided by the sensor may represent an analog value.

FIG. **8** shows a diagram of various inputs from sensors that can be used and actions that can be performed in accordance with at least one embodiment of the invention. Any one of the devices described herein, including the devices shown in FIGS. **2**, **3**, **4**, **5**A and **5**B, may operate in accordance with the use of artificial intelligence as represented by FIG. **8**. One or more inputs on the left side of FIG. **8** are received from various sensors of a device and are input into the artificial intelligence (AI) logic. One or more actions on the right side of FIG. **8** may be implemented by the AI logic automatically in response to any combination of the inputs. In one implementation of this embodiment, the actions are implemented substantially immediately after the data is sensed by one or more sensors.

Exemplary inputs of FIG. **8** may include, for example, proximity data, proximity data and blob detect data (e.g., from a multipoint touch input screen), proximity data and accelerometer data, accelerometer data and blob detect data, proximity data and temperature data, proximity data and ambient light data, and numerous other possible combinations.

Exemplary actions of FIG. **8** may include, for example, turning off the backlight of the portable device's display, suppressing the user's ability to input at the user interface (e.g., locking the input device), changing the telephone's mode, and the like. It will be appreciated that combinations of the above actions may also be implemented by the AI logic. For example, the AI logic may both turn off the display's backlight and suppress the user's ability to input at the user interface.

AI logic of FIG. **8** performs an AI (artificial intelligence) process. In certain embodiments, the AI process may be performed without a specific, intentional user input or without user inputs having predetermined data associated therewith (e.g., key inputs). The artificial intelligence process performed by the AI logic of FIG. **8** may use a variety of traditional AI logic processing, including pattern recognition and/or interpretation of data. For example, the AI logic may receive data from one or more sensors and compare the data to one or more threshold values and, based on those comparisons, determine how to interpret the data. In one embodiment, a threshold value may represent a distance which is compared to a value derived from a light intensity measurement in a proximity sensor. A light intensity measurement which represents a distance larger than the threshold value indicates that the object (which reflected the emitter's light) is not near, and a light intensity measurement which represents a distance smaller than the threshold value indicates that the object is near. Further, the input data may be subject to at least two interpretations (e.g. the data from a proximity sensor indicates that the user's head is near to the sensor, so turn off the back light, or the data from the proximity sensor indicates the user's head is not near, so leave the backlight under the control of a display timer), and the AI process attempts to select from the at least two interpretations to pick an interpretation that predicts a user activity. In response to the interpretation (e.g. the selection of one interpretation), the AI logic causes an action to be performed as indicated in FIG. **8**, wherein the action may modify one or more settings of the device. In at least certain embodiments, the AI logic may perform an AI process which interprets the data from one or more sensors (which interpretation requires the AI process to select between at least two possible interpretations) and which selects an action (e.g. modifying a setting of the device) based on both the interpretation of the sensor data and the current state of the device; the method shown in FIG. **11**A is an example of the use of information about the current state of the device (e.g. whether the user is currently communicating through the telephone in the device) along with an interpretation of sensor data (proximity data in the case of FIG. **11**A).

In certain embodiments, the AI process may perform traditional methods of pattern recognition on the sensor data. For example, the rate of change of the distance between the device and the user's ear may have a pattern (e.g. revealing a deceleration as the user moves the device closer to their ear), and this pattern in the rate of change of distance may be detected by a pattern matching algorithm. The phrase "artificial intelligence" is used throughout to mean that a conclusion (whether explicit or implicit) can be drawn from data available from one or more sensors about a mode of usage by the user of the device. This conclusion may or my not be expressed in the device (e.g., "the user is talking on the phone") but it will be mapped to specific actions or settings for the device that would be appropriate if the user was using the device in that way. For example, a telephone may be pre-programmed such that whenever it detects (1) a voice being spoken into the microphone, (2) that the phone is connected to a network, and (3) the proximity sensor is active, then the screen backlight will be dimmed. Such pre-programming may involve simple logic (e.g. simple combinatorial logic), but would nonetheless be within the scope of artificial intelligence as used herein. While learning, statistical analysis, iteration, and other complex aspects of AI can be used with the present invention, they are not required for the basic artificial intelligence contemplated. Likewise, the word "analyze" does not imply sophisticated statistical or other analysis, but may involve observation of only a single threshold or datum.

The AI processing, in at least certain embodiments, may be performed by a processor or processing system, such as digital processing system **103**, which is coupled to the one or more sensors that provide the data which form the inputs to the AI process. It will be appreciated that an AI process may be part of one or more of the methods shown in FIGS. **10** and **11**A-**11**F.

In at least certain embodiments, the device, which operates according to any of those methods, may have at least one input device (e.g. a keypad or keyboard or touch input panel) which is designed to receive intentional user inputs (e.g. which specify a specific user entry) in addition to one or more sensors which are distinct and separate from the at least one input device and which sensors are not designed to receive intentional user inputs. In fact, a user may not even be aware of the presence of the one or more sensors on the device.

FIGS. **9**A-C illustrate exemplary user activities that can be determined based on input data acquired by the one or more sensors of the portable device. Exemplary user activities include, but are not limited to, the user looking directly at the portable device (FIG. **9**A), the user holding the portable device at or near their ear (FIG. **9**B), the user putting the portable device in a pocket or purse (FIG. **9**C), and the like.

Additional information about user activities and/or gestures that can be monitored in accordance with embodiments of the present invention are disclosed in U.S. patent application Ser. No. 10/903,964, titled "GESTURES FOR TOUCH SENSITIVE INPUT DEVICES," filed Jul. 30, 2004, U.S. patent application Ser. No. 11/038,590, titled "MODE-BASED GRAPHICAL USER INTERFACES FOR TOUCH

SENSITIVE INPUT DEVICES," filed Jan. 18, 2005, all of which are incorporated herein by reference in their entirety.

FIG. **10** is a flowchart illustrating a method **200** for automatically responding to certain user activities with respect to a portable device. In one embodiment, method **200** includes, but is not limited to, gathering sensor data designed to indicate user activity with respect to a portable device, and executing machine-executable code to perform one or more predetermined automated actions in response to the detection of the user activity.

The method **200** may be performed by any one of the devices shown in FIGS. **2**, **3**, **4**, **5**A, **5**B, **6** and **12** and may or may not use the artificial intelligence process shown in FIG. **8**. Operation **202** gathers sensor data, from one or more sensors; the sensor data provides information about user activity. For example, a proximity sensor may indicate whether the device is near the user's ear; a temperature sensor, an ambient light sensor (or a differential ambient light sensor) and a proximity sensor may together indicate that the device is in the user's pocket; a gyroscope and a proximity sensor may together indicate that the user is looking at the device. In operation **204**, the data from the one or more sensors is analyzed; this analysis may be performed by one or more processors within the device, including a processor within one or more of the sensors. The analysis attempts to predict user activity based on the sensor data. It will be appreciated that a prediction from this analysis may, in some cases, be wrong. For example, if a user places a finger over a proximity sensor when the user holds the device, this may cause the analysis to incorrectly conclude that the device is near the user's head or ear. In operation **206**, one or more device settings may be adjusted based upon, at least in part, the analysis of the data from the one or more sensors. This adjusting may include changing an illumination setting of the device or other actions described herein.

FIGS. **11**A-F illustrate exemplary methods for sensing data and automatically responding to the sensed data, and these methods may be performed by any one of the devices shown in FIGS. **2**, **3**, **4**, **5**A, **5**B, **6** and **12** and may or may not use the artificial intelligence process shown in FIG. **8**. It will be appreciated that several variations can be made to the illustrated methods, including variations to the data sensed, analysis of the data and the response(s) to the sensed data.

The method of FIG. **11**A includes optional operation **220** in which the device determines if the user is communicating through the telephone within the device. This may be performed by conventional techniques known in the art which can sense when a telephone call is in progress or when the user is otherwise communicating through the telephone or other communication device. In operation **222**, proximity sensor data is received from one or more proximity sensors on the device. Then in operation **224**, the proximity sensor data is analyzed. For example, the data is analyzed to determine whether an object, such as the user's ear or head, is near the device. This analysis is used to decide whether and how to adjust the device's settings as shown in operation **226**. One or more settings of the device may be automatically adjusted based on the analysis of the proximity sensor data and optionally based on whether or not the user is communicating through the telephone or other communication device. For example, if the proximity sensor indicates that the device is near the user's head or ear and it has been determined that the user is communicating through the telephone, then the device determines that the user is talking or otherwise communicating on the telephone or other communication device by having the device next to the user's ear as shown in FIG. **9**B. In this situation, the device automatically changes the manner in which data from one or more input devices is processed, such as suppressing a user's ability to make intentional inputs on an input device, such as a keypad or a touch input panel on the device. In addition to suppressing intentional inputs, the device may automatically adjust a power setting of one or more displays of the device. If, on the other hand, the device determines that the user is not communicating though the telephone while the proximity sensor data indicates that an object is near to the device, the device may decide not to modify an illumination setting of the display and to not suppress the user's ability to enter intentional user inputs on an input device. The suppressing of inputs may occur in one of a variety of ways. for example, inputs may be suppressed by turning off or reducing power to the input device such that it is not operational while in this mode; in another example, inputs may be suppressed while in this mode by not processing any inputs which are received by a fully powered input device; in yet another example, inputs are not processed as intentional inputs but are processed to confirm they are "blobs" resulting from touches or near touches on the input device. In the last example, even though an input appears to be an activation of a key (the "3" button on a keypad) or other user interface item, the input is not processed as an activation of that key but rather is processed to determine whether it is a "blob."

FIG. **11**B shows a method of an embodiment of the present inventions which relates to a technique for controlling when data from an input device is processed as an input and when it is ignored as an intentional user input. In operation **230**, the device receives movement data from one or more sensors. These sensors may include an accelerometer or a motion sensor or other types of sensors which indicate movement data. These sensors may be designed to distinguish between rapid movements and slow movements. This is particularly true if the movements involve high levels of acceleration. It is assumed in this embodiment that rapid movements may be so rapid that it is unlikely the user could be intending to enter a user input and hence the device may decide to ignore inputs which occur when such sensors indicate that the movement is faster than a threshold movement value. The movement data is analyzed in operation **232** to determine whether or not to automatically suppress a user's ability to input key inputs or other inputs based on the device's movement. In operation **234**, the device may automatically suppress a user's ability to enter inputs on an input device in response to the analysis in operation **232**.

FIG. **11**C relates to an embodiment of the present inventions in which data relating to a location of the device and data relating to movement of the device are analyzed to determine whether or not to adjust one or more settings of the device. In operation **260**, data relating to the location of the device is received; this data may, for example, be provided by a proximity sensor. In operation **262**, data relating to device movement is also received. This data may be from a motion sensor or from an accelerometer. In operation **264**, the data relating to location and the data relating to device movement are analyzed to determine whether or not to adjust a setting of the device. This analysis may be performed in a variety of different ways. For example, the data relating to device motion may show a pattern of movement which matches the movement which occurs when a user moves the device from the user's pocket to the user's head. The analysis may further determine that the proximity data or other data relating to location showed that the device was not near the user's head or another object until near the end of the movement. In such a situation, the analysis would determine that the user has pulled the device from their pocket and placed it against the user's ear. In

operation **266**, one or more settings of the device are adjusted automatically, without any intentional user input, based upon the analysis. For example, an adjustment may be made in the manner in which data from an input device, such as a touch input panel, is processed. For example, inputs to the input device are not processed as intentional user inputs, effectively suppressing the inputs. In addition, a display's illumination setting may be adjusted. For example, if the analysis of operation **264** determines the user has moved the device from a location away from the ear to a location close to the ear then, in one embodiment, an illumination setting may be adjusted and the user's ability to enter intentional inputs into an input device may be suppressed.

FIG. **11**D shows an embodiment of the present inventions in which data relating to location and data relating to temperature is processed through an analysis to determine whether or not to adjust one or more device settings of the device. In operation **270**, data relating to location, such as data from a proximity sensor, is received. In operation **272**, data relating to temperature, such as temperature data or temperature differential data, is received. In operation **274**, the data relating to location and the data relating to temperature are analyzed to determine whether to adjust one or more settings of the device. In operation **276**, one or more device settings are adjusted in response to the analysis of operation **274**.

FIG. **11**E shows an embodiment of the present inventions in which data relating to location of a device and data relating to touches on a touch input panel of the device are analyzed to determine whether to adjust a setting of the device. In this embodiment, data relating to location of the device is received in operation **290** and data relating to touches on a touch input panel is received in operation **292**. The data relating to location may be from a proximity sensor. The data relating to touches on a touch input panel may be from a multi-point touch input panel which is capable of detecting multiple point touches which may occur when a user's face is pressed against or is otherwise near the touch input panel. In operation **294**, the data relating to location and the data relating to touches are analyzed to determine whether to adjust a setting of the device. As a result of this analysis, in operation **296**, one or more device settings are adjusted. For example, the adjustment may include automatically reducing power to the backlight of a display or changing the manner in which data from the touch input panel is processed, or both adjustments.

A mode of the device may be used in order to determine whether to or how to adjust a setting of the device. The mode of the device may include any one of a variety of modes or conditions, such as speakerphone mode or non-speakerphone mode, battery powered mode or not battery powered mode, call waiting mode or not call waiting mode, an alert mode in which the device may make a sound, such as the sound of an alarm, etc. The data relating to user activity (e.g. data from one or more sensors, such as a proximity sensor and/or a touch input panel, which is capable of detecting blobs from a face) is analyzed relative to the mode of the device and the analysis attempts to determine whether to adjust a setting of the device. One or more device settings may be adjusted based on the sensed user activity and the device mode. For example, the device may automatically switch from speakerphone mode to non-speakerphone mode when proximity data, and optionally other data (e.g. data from a motion sensor and an ambient light sensor) indicate the user has placed the device, which in this case may be a telephone, next to the user's ear. In this example, the device has automatically switched from speakerphone mode to non-speakerphone mode without any intentional input from the user which indicates that the switch should occur. Another method involves adjusting an alert or alarm volume depending on whether or not the device is near to the user's ear. In this example, if the data relating to user activity indicates that the device is adjacent to the user's ear and if the mode of the device is set such that alarms or alerts will cause the device to make a sound, then the device will automatically change the volume level for an alert or an alarm from a first level to a second level which is not as loud as the first level.

FIG. **11**F shows an embodiment of the inventions in which data from a device configuration detector, such as a hinge detector, is used to determine how to process data from one or more sensors on the device. In one embodiment, this method shown in FIG. **11**F may be used with the device shown in FIGS. **5**A and **5**B (and the proximity sensor referred to in FIG. **11**F may be proximity sensor **84** in FIG. **5**A). In particular, a hinge detector which is coupled to the hinge **87** may detect whether the device is open as shown in FIG. **5**A or closed as shown in FIG. **5**B. Other configuration detectors may indicate whether a slide out input device (e.g. a slide out keyboard) or other type of input device has been pulled out (or swung out) or not from a portion of the device. In operation **320**, the device determines whether data from a hinge detector shows that the device is open. If the device is not open, then in operation **322**, data from a proximity sensor is ignored if the proximity sensor is disposed on an interior surface of the device. Optionally, the power to the proximity sensor may be reduced by, for example, turning off the proximity sensor when the device is in a closed state. If it is determined in operation **320** that the device is open, then in operation **324**, data from the proximity sensor is processed to determine whether the device is placed near an object, such as the user's ear. If it is determined from the processing of operation **324** that the device is not near the user's ear, then the display timer which controls the time that the display is illuminated, is allowed to continue to run in operation **326**. This display timer may be similar to the display timer which operates in the method shown in FIG. **1**. If, in operation **324**, it is determined that the device is near the user's ear, then in operation **328**, power to an illuminator of the display is reduced. This may be performed by setting the display timer's value to a time out state to thereby cause the display's illuminator to be powered off. It will be appreciated that the method of FIG. **11**F may save additional battery life by reducing power to the illuminator of the display before the display timer runs out.

It will be appreciated that a method which is similar to the method shown in FIG. **1** may be used in addition to at least certain embodiments of the inventions which adjust illumination settings. For example, in the embodiment shown in FIG. **11**A, a display timer which has been started (e.g. in operation **14** of FIG. **1**) may continue to count while the method shown in FIG. **11**A is performed. The display timer will count, while the method of FIG. **11**A is being performed, until its time out state is reached and, upon doing so, the display timer may cause the illumination setting to be changed before the method of FIG. **11**A is completed. In this case, the illumination setting is controlled by both the display timer and one or more sensors of at least certain embodiments of the inventions which cause an adjusting of illumination settings based upon the analysis of data from one or more sensors.

The phrase "proximity sensor" is used throughout to mean a sensor, such as a capacitive, temperature, inductive, infrared or other variety of sensor, which is capable of detecting whether an object is present within a certain distance of the sensor. A primary object of this detecting may be the head of the user (or any other object that would present viewing of the display screen).

Any of the embodiments of the inventions may include one or more user interface controls which allow a user to override a result caused by one or more sensors. For example, a control, such as a button, may be pressed by the user to cause the display to return to full power after a proximity sensor has caused the display to enter a reduced power consumption state. In another example, the user interface control may be a sensor (or group of sensors), such as an accelerometer, which detects a user interaction with the device (e.g. shaking the device), and the user interaction has been set up to cause an overriding of a state caused by one or more sensors.

Certain embodiments of the inventions may employ one or more light sensors which provide data relating to light, which data is analyzed to determine whether or not to adjust one or more settings of a device, such as wireless device **100**. Ambient light level data may be provided by an ambient light sensor which indicates the level of light intensity surrounding that sensor. Ambient light differential data may be obtained form two or more ambient light sensors which are disposed at different positions on the device. For example, one ambient light sensor may be on one side of the device, and another ambient light sensor may be on another side of the device. A different in the light intensity levels may be determined by comparing the data from these two ambient light sensors on two different sides or surfaces of the device. There are a variety of possible uses of a light sensor. A light sensor may be used with a proximity sensor to determine when a device is placed in a pocket to cause the device to be set in vibrate mode only or vibrate mode with audible ringing. In another example, in response to a light sensor determining that the ambient light is very low, and optionally in response to a user having set the device to visibly light up to show an incoming call when the ambient light is very low, the device may automatically be put in a "light ring" mode when it is dark so that instead of an audible ring from the device, the display flashes visibly (e.g. by repeatedly turning on and off the backlight) to indicate an incoming call. Another exemplary use of a light sensor involves using it as an alarm indicating that a dark room (or environment) has become brighter (e.g. the sun has risen or a door to a darkened room is opened to let light into the room). A light sensor may also be used to cause a device to automatically act as a source of light (e.g. as a flashlight, in effect) upon sensing a low ambient light level.

FIG. **12** shows another example of a device according to an embodiment of the inventions. This device may include a processor, such as microprocessor **402**, and a memory **404**, which are coupled to each other through a bus **406**. The device **400** may optionally include a cache **408** which is coupled to the microprocessor **402**. This device may also optionally include a display controller and display device **410** which is coupled to the other components through the bus **406**. One or more input/output controllers **412** are also coupled to the bus **406** to provide an interface for input/output devices **414** and to provide an interface for one or more sensors **416** which are for sensing user activity. The bus **406** may include one or more buses connected to each other through various bridges, controllers, and/or adapters as is well known in the art. The input/output devices **414** may include a keypad or keyboard or a cursor control device such as a touch input panel. Furthermore, the input/output devices **414** may include a network interface which is either for a wired network or a wireless network (e.g. an RF transceiver). The sensors **416** may be any one of the sensors described herein including, for example, a proximity sensor or an ambient light sensor. In at least certain implementations of the device **400**, the microprocessor **402** may receive data from one or more sensors **416** and may perform the analysis of that data in the manner described herein. For example, the data may be analyzed through an artificial intelligence process or in the other ways described herein. As a result of that analysis, the microprocessor **402** may then automatically cause an adjustment in one or more settings of the device.

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will be evident that various modifications may be made thereto without departing from the broader spirit and scope of the invention as set forth in the following claims. The specification and drawings are, accordingly, to be regarded in an illustrative sense rather than a restrictive sense.

What is claimed is:

1. A portable data processing device comprising:
- a display;
- an input device;
- a proximity sensor;
- at least one processor coupled to the input device and to the display and coupled to the proximity sensor to receive data from the proximity sensor;
- a radio frequency (RF) transceiver coupled to the processor;
- a speaker coupled to the RF transceiver;
- a microphone coupled to the RF transceiver;
- a storage device coupled to the at least one processor;
- an ambient light sensor (ALS) coupled to the at least one processor, wherein the at least one processor is configured to change the power setting of the display based upon data from the ALS;
- wherein the processor is configured to determine, based upon at least the data from the proximity sensor, whether to change a state of processing of data from the input device relative to receipt of user inputs;
- wherein the input device comprises a multi-touch input panel which is integrated with the display and which is capable of determining multiple, separate concurrent touches on the multi-touch input panel and wherein the multi-touch input panel provides touch data derived from one or more touches to the multi-touch input panel and wherein when the data from the proximity sensor determines a first proximity state, the touch data is processed as an intentional user input and when the data from the proximity sensor determines a second proximity state, the touch data is either not processed as an intentional user input or is not provided by the multi-touch input panel;
- wherein the second proximity state occurs when the portable data processing device is proximate to the user's ear;
- wherein the storage device is configured to store media for playback on the portable data processing device, and wherein the data from the proximity sensor represents at least one of a distance and a rate of change of distance; and
- wherein the at least one processor is configured to change the state of processing of the touch data from the multi-touch input panel in response to a change in the data from the proximity sensor.

2. The portable data processing device as in claim **1** wherein the display occupies a large portion of a surface of a housing of the portable device.

3. The portable data processing device as in claim **2** wherein the portable device does not include a hinge.

4. The portable data processing device as in claim **2** wherein the processor is configured to determine whether multiple concurrent touches resemble contact with a user's face.

5. The portable data processing device as in claim 4 further comprising:

a user interface coupled to the storage device, the user interface being configured to allow the user to select a particular content in the media for playback and to scroll through a listing of the media.

6. The portable data processing device as in claim 5 wherein the media for playback comprises at least one of audio or video or audio and video together.

7. The portable data processing device as in claim 6 wherein the processor is configured to determine whether a user is communicating with another device through the RF transceiver and is configured to determine whether to change the state of processing of data from the input device and to alter the power setting based on both the data and whether the user is communicating with another device and wherein data from the input device is not processed as an intentional user input when (a) the data from the proximity sensor indicates that the portable data processing device is near the user and (b) the user is communicating with another device.

8. The portable data processing device as in claim 7 wherein the state of processing of the data from the input device and the power setting of the display are both changed in response to a change in the data from the proximity sensor.

9. The portable data processing device as in claim 8 wherein the data from the proximity sensor represents a rate of change of distance; and

wherein the at least one processor is configured to change the state of processing of the touch data from the multi-touch input panel and the power setting of the display in response to a change in the data from the proximity sensor.

10. The portable data processing device as in claim 6 wherein the ambient light sensor (ALS) senses a level of ambient light and wherein the at least one processor is configured to change the illumination level of the display to dim the display based upon at least data from the ALS.

11. A portable data processing device comprising:

a display;

an input device;

a proximity sensor;

at least one processor coupled to the input device and to the display and coupled to the proximity sensor to receive proximity data from the proximity sensor

a radio frequency (RF) transceiver coupled to the processor;

a speaker coupled to the RF transceiver;

a microphone coupled to the RF transceiver;

a storage device coupled to the at least one processor;

an ambient light sensor (ALS) coupled to the at least one processor, wherein the at least one processor is configured to change the power setting of the display based upon data from the ALS;

wherein the processor is configured to determine, based on at least the proximity data, whether to change a state of processing of input data from the input device relative to receipt of user inputs;

wherein the input device comprises an input panel which is integrated with the display and which is capable of determining a touch on the input panel and wherein the input panel provides touch data and wherein when the data from the proximity sensor determines a first proximity state, the touch data is processed as an intentional user input and when the data from the proximity sensor determines a second proximity state, the touch data is either not processed as an intentional user input or is not provided by the input panel;

wherein the second proximity state occurs when the portable data processing device is proximate to the user's ear;

wherein the storage device is configured to store media for playback on the portable data processing device, and wherein the data from the proximity sensor represents at least one of a distance and a rate of change of distance; and

wherein the at least one processor is configured to change the state of processing of the touch data from the input panel in response to a change in the data from the proximity sensor.

12. The portable data processing device as in claim 11 wherein the display occupies a large portion of a surface of a housing of the portable device.

13. The portable data processing device as in claim 12 wherein the portable device does not include a hinge.

14. The portable data processing device as in claim 12 further comprising:

a user interface coupled to the storage device, the user interface being configured to allow the user to select a particular content in the media for playback and to scroll through a listing of the media.

15. The portable data processing device as in claim 14 wherein the processor is configured to determine whether a user is communicating with another device through the RF transceiver and is configured to determine whether to change the state of processing of data from the input device and to alter the power setting based on both the data and whether the user is communicating with another device and wherein data from the input device is not processed as an intentional user input when (a) the data from the proximity sensor indicates that the portable data processing device is near the user and (b) the user is communicating with another device.

16. The portable data processing device as in claim 15 wherein the state of processing of the data from the input device and the power setting of the display are both changed in response to a change in the data from the proximity sensor.

17. The portable data processing device as in claim 15 wherein the ambient light sensor (ALS) senses a level of ambient light and wherein the at least one processor is configured to change the illumination level of the display to dim the display based upon at least data from the ALS.

18. The portable data processing device as in claim 16 wherein the data from the proximity sensor represents a rate of change of distance; and

wherein the at least one processor is configured to change the state of processing of the touch data from the input panel and the power setting of the display in response to a change in the data from the proximity sensor.

* * * * *